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## From the editor's desk...

In any future energy scenario, energy efficiency on the demand side and renewable energy on the supply side become intrinsic parts of the overall strategy. And more and more attention is paid to them not only from the climate change perspective, but more importantly, from countries' energy security point of view. Huge investments, both from the governments as well as the private sector are being made in renewable energy sector for the last few years. But one is forced to take notice if investments in solar energy worth multi-billion dollars come from Mr Warren Buffet, known as one of the smartest and visionary investors globally. Renewables have started moving out of their protective cocoon to the real commercial world.

However, when dealing with renewable energy resources, leaving apart hydro energy, predominantly one comes across resources and technologies that are land-based, such as biomass energy, solar energy, or onshore wind energy. Indeed, with oceans covering more than 70 per cent of the earth's surface, they form the world's largest solar collectors. Then there are energy resources like wave and tidal. While there are challenges associated with them, many of the constraints that the land-based technologies have to face, including the land itself, become redundant in case of ocean energy.

Public also has become much more conscious about the implications of different energy resources, their utilization, and their transportation; the environmental issues related to Keystone XL pipeline being a case in point. The choices for energy future have become clear!

*Amit Kumar*

**Amit Kumar**  
Director, TERI

Editor: Amit Kumar Radheyshayam Nigam

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Your article The IT Crowd in the previous issue of Energy Future made for inspiring reading. It is very encouraging to see a giant like Google trying to step up its game vis-à-vis renewable energy. Being an IT professional myself, I'd like to see my own employer take up measures to actively reduce our carbon footprint. The section covering Iceland was also fascinating. Who knew that such a cold energy utilized so much geothermal energy? Kudos to the magazine for linking such varied subjects into a coherent article!

**Vimal Nair**  
Bangalore

I was pleased to read the article on Biomass Power in Punjab, as it shows alternative energy sources such as biomass energy are being pursued by private players in the Indian market. If this project is successful, I can confidently say that many farmers in rural India will be able to provide feedstock for fuelling these biomass power plants. Farmers in India have always had a bad hand when it comes to gratitude for the service they provide to the country, and by having small-scale electricity generation facilities in their hands that allows them to enjoy the benefits of electricity generation it is possible to stem the mass migration of Indians from rural to urban areas in search of a better life that sees our cities clogged up and overflowing with people that leads to poverty and crime as a consequence. Perhaps as more rural Indian places are able to access energy through alternative sources and develop cleanly on their own right, we might even see a situation such as in the United States and the UK where people from cities are moving to smaller communities as rural villages and towns in developed countries have essentially the same benefits of cities without the drawbacks of city life such as the cramped living conditions and pollution.

**A C Dharmavaram**  
Ajmer

I thoroughly enjoy reading Energy Future. I find the material published very relevant and up to date. At a time of depleting resources, it is refreshing to learn what all one can achieve and develop with available renewable energy sources. Congratulations, the magazine is definitely a winner in the league.

**Subhashini Davidar**  
Pune, Maharashtra

As always, I am always pleased to receive my copy of Energy Future! There are very few magazines in the market today that I feel match up to the quality of articles that you publish which are both informative and engaging. Working in the field of energy regulation, I must say that acquainting myself with the contents of this magazine has helped me immensely in my research work. In the current issue, I found the article on The Trans-Caspian Gas Pipeline especially insightful. It would be interesting to see what comes up in this field in the future. I would like to congratulate the entire team for all the good work being done in bringing out this magazine!

**Anika**  
Silchar

Thank you very much for your encouragement. The editorial team of Energy Future will ensure that the magazine caters to your information and knowledge needs. We welcome your suggestions and comments to further improve our content and presentation.  
Email: teripress@teri.res.in  
**Editor**  
Energy Future

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**GAIL'S PIPE DREAM**

The Madras High Court has stayed a Tamil Nadu government order directing removal of pipelines laid by the Gas Authority of India Limited (GAIL) in farmlands in the state for the Kochi-Bangalore pipeline project. This has come as a relief to both GAIL and the industry in the state. The state government had directed officials to remove the pipelines already laid in farmlands in Coimbatore, Tirupur, Erode, Namakkal, Salem, Dharmapuri, and Krishnagiri.

Chief Minister, J Jayalithaa, made this announcement much to the disappointment of the industry, which was looking forward to increased supply of natural gas in the South. India could suffer a 'huge long-term disadvantage' because of inadequate gas grid, said B Santhanam, Chairman, CII, Southern Region. The Chief Minister said that the farmers in the seven districts the pipeline crosses are worried about their loss of livelihood. She wanted GAIL to align the pipeline along highways to avoid farmland and habitations, remove pipeline-related structures from the fields and restore them to original condition, and compensate farmers for loss.

Source: www.indianexpress.com

**COAL REGULATORY BILL GETS CABINET NOD**

The government has approved a Bill for setting up a regulator for the coal sector paving the way for a much-awaited watchdog for the sector. The Union Cabinet, which met recently approved the Independent Coal Regulatory Authority Bill, which is likely to be introduced in the Monsoon Session of Parliament. The proposed regulatory mechanism, however, would have no say in pricing of the fuel or in allocation or de-allocation of coal blocks.

A senior coal ministry official said that the regulator would be tasked with the recommendation of the guiding principles for pricing coal and will have to suggest ways for optimizing production in the coal sector. The coal ministry in its proposal to the Cabinet had suggested that the proposed watchdog should act as an adjudicating body to mitigate disputes between the coal companies and their buyers.

The Indian Express had on 25 April, 2013 reported that the coal ministry had re-written the draft Bill on the regulator clipping powers of the watchdog on pricing and allocations of coal blocks. An independent regulator for the coal sector is considered by the government to be important for fixing guidelines for helping in price determination, improving competitiveness in the e-auctions, setting trading margins and increasing transparency in the allocation of reserves. The regulator will also regulate methods for testing for declaration of grades or quality of coal, specify procedure for automatic coal sampling and monitor closure of mines and accord approval of mining plans. The power ministry has been demanding a watchdog to curb 'profiteering' tendencies of the coal companies.

Source: www.indianexpress.com



**DOMESTIC NATURAL GAS PRICE DOUBLED**

The Cabinet Committee on Economic Affairs (CCEA) has decided to double the price of domestic natural gas, from \$4.2 to \$8.4 a million British thermal unit (mBtu), from April 2014, a decision that might hit the power and fertilizer sectors the most. According to Petroleum Minister, M Veerappa Moily, 'The government decided to revise the natural gas price on the basis of the suggestions made by the Rangarajan committee last year. The new mechanism will be applicable from April 2014 and the price will come up for a quarterly review after that. This will be applicable for a period of five years.'

As per an official source, the CCEA has decided that the government would absorb the losses of the power and fertilizer sectors. However, the quantum of absorption would be determined by the ministries concerned. The decision could cause a loss of Rs 42,000 crore for about 28,000 MW of power capacity dependent on gas, while the fertilizer subsidy might rise by Rs 13,200 crore a year. On the other hand, the price increase to \$8.4 an mBtu will add Rs 21,000 crore annually to the profits of major public and private sector companies.

The Rangarajan panel had proposed a pricing mechanism that would take an average of the US, Europe, and Japanese hubs and then average it out with the netback price of

imported liquefied natural gas (LNG) to decide the sale price of gas produced domestically. Accepting the formula suggested by the Rangarajan panel, would also affect cost to consumers.

Source: www.business-standard.com



**DAMS CONTROLLED FLOODS, SAYS WATER PANEL CHIEF**

Countering what he called 'uninformed speculation', Central Water Commission (CWC) Chairman, Rajesh Kumar, said that dams in Uttarakhand had reduced the flooding of towns and villages after torrential rains. He said the water level in the dam was under control and did not breach the maximum tolerance zone even at the height of the rains and flooding.

The construction of the Tehri dam had been bitterly contested by interest groups. They had claimed that the stored water could create a disaster in the earthquake-prone Himalayan region and lead to a flood havoc. But Kumar pointed out that this was an uninformed debate as dams in India pass through several layers of clearances before construction starts. The CWC is the country's premier technical organization for water management. He said the devastation in the hill state was restricted at places where water flowing down the hills was successfully trapped in reservoirs. There was havoc where there were no such reservoirs.

Kedarnath was ravaged by water coming down the hills above the snowline and had no safety zones, such as dams where the flow could be channeled. The pilgrim centre remains snow-bound for six months in a year and therefore has no major commercial or large residential structures in

the area. 'So there is no question of any human-created reason for the floods from either industry or from the dams', Kumar added.

Source: www.indianexpress.com





**INDIA SLIPS TO 8TH IN RENEWABLE ENERGY INDEX**

According to an Ernst & Young survey, high entry-barriers for foreign investors and the rising cost of financing has led to India slipping to a low eighth position on the renewable energy country attractive index in the first quarter of 2013.

According to the report, Renewable Energy Country Attractiveness Index, India's ranking has slipped from fourth to the eighth position. 'A high barrier to entry for external investors causes India to score lower than most of its top ten rivals. Also, bankability is jeopardized by the high cost of financing and significant infrastructure barriers here,' E&Y India partner and national leader for clean-tech, Sanjay Chakrabarti, said.

However, the index sees the country gaining the 'hot spot' as the market with increased focus on the role of renewable energy, driving new levels of power sector investment, and aiming to nearly double the amount it generates from renewable sources.

'While the country's rating may have slipped, there are significant positives. India is only behind Belgium in the priority the renewable sector receives,' he said. At the operational level, E&Y said, 'Withdrawal of accelerated depreciation caused the overnight disappearance of the wind retail market. However, this has also brought to the fore the independent power producers, mostly backed by large PEs. The wind sector's size has therefore shrunk, but it has also arguably resulted in a stronger market, with IPPs committed to setting up quality assets.' On the solar energy

front too, there has been active interest in the bids across states, the phase-II of the national mission is eagerly awaited, Chakrabarti said. He however said the country is embroiled in trade wars that are sweeping through the global solar market.

Source: www.financialexpress.com



**INDIA-TURKEY TO COOPERATE IN RENEWABLE ENERGY**

India and Turkey have agreed to enhance their cooperation in the field of renewable energy. This was decided at a meeting held between the Turkish Energy Minister Taner Yildiz and Dr Farooq Abdullah, Minister of New and Renewable Energy at Ankara.

Dr Abdullah is visiting Turkey along with a high-level delegation to explore greater opportunities for cooperation



and collaboration between Indian and Turkey. Dr Abdullah briefed his counterpart on the energy situation in India and India's plans to add over 30 GW of renewable energy to its energy mix in the next five years. He also dwelt on the success of the wind programme as well as the significant cost reductions in solar energy through the Jawaharlal Nehru National Solar Mission (JNNSM).

The Turkish leader said that Ankara hopes to diversify its energy mix by introducing a large component of renewables. It has considerable potential in wind, hydro, solar and geothermal energy. It imports over 90 per cent of its oil, gas, and fossil fuel requirement.

Dr Abdullah offered India's support and expertise to Turkey in setting up projects in wind, solar and hydropower. He also offered training slots in India to Turkish scientists, engineers and technicians through the ITEC programme. The Indian Minister expressed his country's desire for a serious and meaningful cooperation with Turkey, especially in renewable energy and offered all possible assistance.

Source: www.greaterkashmir.com

**INDIA'S TCIL TO SUPPLY GREEN ENERGY SOLUTIONS TO OMANTEL**

As a turnkey supplier, TCIL will not only help telecom companies build environmentally friendly mobile towers, but it has also planned to handle the entire chain of vendor selection, equipment procurement, commissioning, maintenance, and systems integration.

According to the reports, executives familiar with the discussions said state-owned TCIL would supply renewable energy solutions, involving a mix of solar, wind or biomass, to power Omantel and Saudi Telecom's tower sites, in return for a share of their consequent energy cost savings.

'TCIL plans to help Omantel and Saudi Telecom choose the best hybrid power solutions, involving a combination of renewable energy and grid power to reduce fuel costs and carbon emissions in those markets,' said TCIL Chairman and Managing Director Vimal Wakhlu.

An Omantel official confirmed the project when contacted by Muscat Daily.

TCIL is a leading Indian government undertaking incorporated in 1978 under the administrative control of Department of Telecommunications, Ministry of Communications and Information Technology. The company is making available its vast and varied telecom expertise to friendly developing countries. TCIL has extended its telecom consultancy and turnkey projects execution services to telecom operators, bulk users and others in India and 80 other countries in Middle East, Africa, and South and South East

Asia. The company has been undertaking various projects in all fields of telecommunications and information technology and also continuously deploying new technologies in the field of telecom software, switching and transmission systems, cellular services, rural telecommunications, optical fibre-based backbone transmission systems.

Source: www.zawya.com



**SOLAIREDIRECT ENERGY INDIA UNVEILS 5.6 MW SOLAR PARK IN RAJASTHAN**

Solairedirect Energy India, a unit of Paris-based Solairedirect Group, unveiled its first project in India, near Phalodi, in Rajasthan. The company inaugurated the 5.6 MW solar park under the Jawaharlal Nehru National Solar Mission (JNNSM).

Minister for New and Renewable Energy Farooq Abdullah inaugurated the project along with Theiry Lepercq, Chairman, Solairedirect Group and Gaurav Sood, MD, Solairedirect Energy India Private Ltd. The solar park was commissioned on 24 February, 2013 in accordance with the schedules agreed with the Indian authorities and will generate 9000 MWh per annum, enough to power 20,000 Indian households.

'We are showing that solar power can make a serious contribution in addressing this country's pressing energy needs with equipment manufactured in India,' said Theiry Lepercq.



The company was the best bidder in the last round of the JNNSM in December 2011 with a Rs 7.49/kWh quote for the project. All photovoltaic cells, modules and inverters used in the project have been sourced from Indian companies, said Solairedirect. Solairedirect has operations in France, India, South Africa, Chile, Thailand, China and the US and has 250 employees and a total 256 MW under operation and construction. It is the second largest solar power producer in France. In 2012, Solairedirect had revenues of 125 million euros and net profit of 9 million euros.

Source: www.indianexpress.com



**UK BOOSTS ESTIMATE OF SHALE GAS RESOURCES**

Britain recently boosted its estimate of shale gas resources in the north of England, renewing government hopes that new supplies could reduce growing dependence on foreign imports.

A report by the British Geological Survey (BGS) estimates there is 1,300 trillion cubic feet (tcf) of gas in rocks in the so-called Bowland shale area, which could transform the country's energy market. Previous estimates have suggested that a total of some 5.3 tcf could be recoverable in Britain as a whole, implying a resource of 53 tcf assuming a 10 per cent recovery rate.

Britain consumed 2.76 tcf of gas last year, according to BP, implying that shale reserves could cover decades of domestic gas demand if all of the gas could be extracted, which is extremely unlikely. Drilling to test the shale over the next few years will prove critical for the country's infant industry, which must also reassure a sceptical public and vocal environmental lobby. Major energy companies are stepping in, with UK utility Centrica recently buying a stake in the country's most advanced shale driller Cuadrilla. French oil major Total is also considering participating in UK's shale industry.

Britain, Europe's largest gas consuming nation, hopes to follow the US into energy independence by exploiting shale gas, but the country's industry is at an early stage and it is not yet known whether shale gas can be produced economically. The government is keen to reduce the country's dependence on gas imports from countries, such as Norway and Qatar, as imports are due to surpass gas from domestic North Sea production by 2015. Britain's Energy Secretary, Ed Davey, is due to announce the estimated size of the shale resources shortly.

Source: www.financialexpress.com



**WORLD BANK TO CUT FUNDING OF COAL-FIRED POWER PLANTS**

The World Bank plans to limit the financing it provides for coal-fired power plants to 'rare circumstances' as part of the global financial body's efforts to address the impact of climate change.

The move was detailed in a 39-page strategy document seen by Reuters. "The World Bank Group will help clients identify alternatives to coal power as they make transitions toward sustainable energy," the report said. It came a day after US President Barack Obama — as part of a sweeping package of climate measures — said the US would stop investing in coal projects overseas and called on multilateral banks to do the same.

A spokesman said the World Bank is committed to helping create universal access to electricity and safe household fuels, doubling the share of renewable energy in the global energy mix, and doubling the rate of improvement of energy efficiency.

'The World Bank Group's energy work is aligned with our twin goals of ending extreme poverty and promoting shared prosperity and the objectives of sustainable energy for all', the bank's Frederick Jones said in a statement.

The paper, titled 'Toward a Sustainable Energy Future for All', was submitted to board members for their review in preparation for a discussion on July 19, and could still be revised. The report said natural gas could play an important role if coal is phased out. "Natural gas, which has half the carbon footprint of coal at the point of combustion, can be the least-cost means of providing flexible electricity supply where demand and supply fluctuate", it said.

Source: www.financialexpress.com



**ENGINEERS HEAD TO SWANSEA FOR TIDAL ENERGY LAGOON WORLD FIRST**

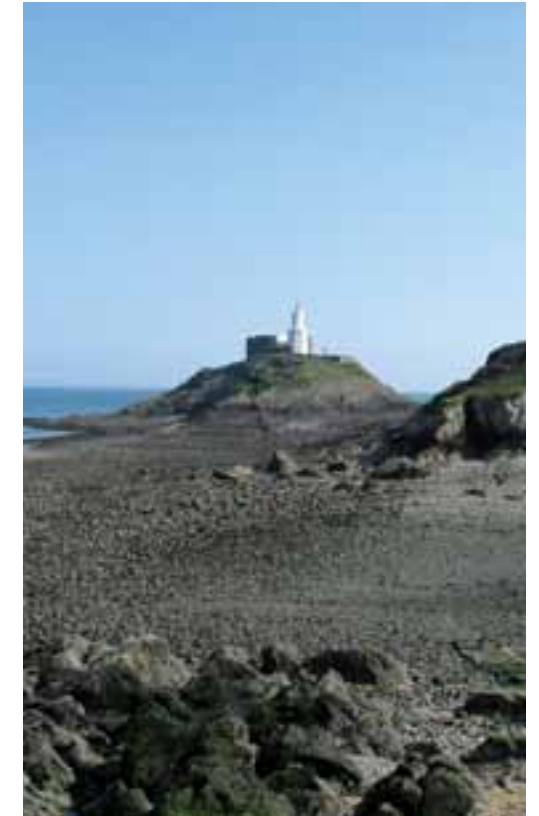
UK firm Tidal Lagoon Power (TLP) is planning a four-week study of the seabed conditions and physical characteristics of Swansea Bay that will inform the company's plans for a 250MW tidal power plant, which would also be the world's first bi-directional tidal lagoon generator. If built, the Swansea Bay project would be the first purpose-built tidal lagoon power plant in the world.

Locally based TLP claims the power station would be connected to the National Grid by 2017, providing predictable, renewable baseload energy for 16 hours a day, saving 200,000 tonnes of CO<sub>2</sub> per year for its design life of over 100 years.

The development will comprise a sand core seawall and hydro turbines mounted in a concrete turbine housing. This seawall will use sandy materials sourced from the seabed within the lagoon, hydraulically filled into long geotextile casings 5m in diameter, and covered with small rocks and then larger rock armour to protect it from environmental damage.

The investigation work, by Environmental Scientifics Group, will provide information about the seabed surface that will enable TLP to optimise its designs for the 20m by 80m walls needed to create the lagoon. The company has already selected the preferred shape of the lagoon from 14 proposed designs but estimates the plans will take until 2015 to finalize before construction can begin — providing it can raise the £10m needed through its current public investment round.

Source: www.theengineer.co.uk



**GREENS PUSH TO BOOST RENEWABLE ENERGY TARGET TO 90 PER CENT**

The Greens have launched a pitch to increase Australia's renewable energy target to 90 per cent by 2030 and tip an extra \$20 billion into Australia's clean energy finance corporation, but have rejected an earlier move to an emissions trading scheme being considered by cabinet.

Greens leader Christine Milne said the minor party wanted to see all of Australia's electricity come from renewable energy sources as soon as possible. She said the first step should be to increase Australia's renewable energy target to 90 per cent by the end of the next decade. The target is currently set to ensure 20 per cent of Australia's electricity comes from renewables by 2020.

A study by the Australian Energy Market Operator released in April 2013 found moving to 100 per cent renewable energy was technically feasible, but would come with costs and significant challenges. It found moving to an 100 per cent renewable energy system would cost \$219 billion to \$338 billion and require wholesale electricity prices to double from current rates.

The Greens also want the Clean Energy Finance Corporation, which was set up as part of a deal between Labor and the Greens on carbon pricing, to receive an extra \$20 billion over 10 years. That would lift its overall funding to the finance corporation to \$30 billion.

The move has been largely backed by industry, who says the current carbon tax price of \$24.15 a tonne is out of kilter with lower international prices at around \$6 and resulting in higher the necessary costs.

Source: www.theherald.com.au





**PHILIPPINES MAKES 100 PER CENT RENEWABLE ELECTRICITY IN 10 YEARS PLAN**

The Worldwatch Institute's Climate and Energy Director, Alexander Ochs, met with the Climate Change Commission (CCC) and high-level representatives of the federal and provincial governments of the Philippines to lay groundwork for a Sustainable Energy Roadmap for the archipelago nation, which aims to shift its current electricity system to 100 per cent renewable energy within a decade.

Climate Change Commissioner and former Senator Heherson Alvarez invited Ochs to present Worldwatch's suggested methodology for a Sustainable Energy Roadmap. 'The Philippines is already a leader in geothermal and hydropower', said Ochs. 'But it's essential now to chart a future that is socially, economically and environmentally sustainable and addresses the key challenge of providing affordable and reliable energy access for all Filipinos.'

To develop a Sustainable Energy Roadmap, Worldwatch analyses an area's potential for energy efficiency gains and undertakes detailed GIS mapping of local renewable energy resources, including biomass, solar, and wind. The Institute also produces an infrastructure inventory that assesses solutions for grid renovation and energy storage. In addition

to technical analysis, the roadmaps explore the socio-economic impacts of diverse energy pathways, including the potential for sustainable energy development to create jobs and reduce electricity and healthcare costs.

CCC Commissioner Alvarez said the government 'is concerned with the latest scientific reports that global warming has accelerated, and believes the country must begin to programme a path from low carbon to zero carbon along a broad partnership of the public interest and private sector.'

Source: www.cleantechnica.com



**EAGLESTONE SEEKS ANGOLA, MOZAMBIQUE RENEWABLE ENERGY INVESTMENTS**

Eaglestone NV intends to invest as much as 40 per cent of a planned 100-million euro renewable energy fund in projects in Angola and Mozambique, using local knowledge to tap new markets. While opportunities are bigger in South Africa, other nations in sub-Saharan Africa where there's a growing appetite for renewables include the two former Portuguese colonies as well as Namibia and Botswana, Eaglestone Chief Executive Officer Pedro Neto said in an interview in London. 'Sub-Saharan Africa is about to take off', he said. 'The growth can be huge, but the size of the projects will be different from South Africa because they don't have the same needs.'

Africa and the Middle East had the biggest regional growth in renewable energy investment last year, with spending growing 228 per cent to \$12 billion, according to a report by the United Nations Environment Programme and Bloomberg New Energy Finance. The gap in clean energy spending between industrialized and developing countries shrank to 18 per cent last year from 250 per cent in 2007, it said.

Neto said Mozambique is studying two possible wind energy projects now, while Angola may develop as much as 200 MW each of wind and solar power by 2017 as part of an 'ambitious' plan to increase the country's total generation capacity to at least 6.2 GW from 1.2 GW now.

Source: www.businessweek.com



**US FOREST SERVICE AWARDS NEARLY \$2.5M FOR RENEWABLE ENERGY PROJECTS**

US Forest Service Chief, Tom Tidwell, announced the award of nearly \$2.5 million in grants to 10 small businesses and community groups for wood-to-energy projects that will help expand regional economies and create new jobs.

'These grants help grow new jobs, support clean energy production and improve our local environments, especially in reducing fire threats', said Tidwell. 'Communities from Massachusetts to Alaska will benefit from the programme this year.'

The projects will use woody material removed from forests during projects such as wildfire prevention and beetle-killed trees, and process woody biomass in bioenergy



facilities to produce green energy for heating and electricity. The awardees will use funds from the Woody Biomass Utilization Grant programme to further the planning of such facilities by funding the engineering services necessary for final design, permitting and cost analysis.

In fiscal year 2012, 20 biomass grant awards from the Woody Biomass Utilization Grant programme totalling approximately \$3 million were made to small business and community groups across the country. This \$3 million investment leveraged more than \$400 million of rural development grants and loan guarantees for woody biomass facilities. The Programme has contributed to the treatment of more than 500,000 acres and removed and used nearly 5 million green tonnes of biomass at an average cost of just \$66 per acre. Grantees also reported a combined 1,470 jobs created or retained as a result of the grant awards.

Source: www.environmental-expert.com

**CONGO CONFIDENT \$12 BILLION HYDROPOWER PLANT WILL PROCEED BY 2015**

The Democratic Republic of Congo will be ready to build the 4,800 megawatt Inga III hydroelectric plant by 2015, after two failed attempts to kick-start the \$12 billion project, Minister of Energy Bruno Kapandji said. Support from the African Development Bank and World Bank, and the emergence of South Africa as a guaranteed purchaser of 2,500 MW of power will help the country find the at least \$8.5 billion of financing it needs.

Inga III is the next step in the creation of a 40,000 megawatt Grand Inga complex, which would be the largest hydropower project in the world. A \$5.2 billion plan to build Inga III by Western Power Corridor, a venture between five southern African countries, fell apart in 2010 because of bad preparation. Two years later, BHP Billiton Ltd, the world's biggest mining company, scrapped plans to finance the hydropower site when it decided not to build a proposed aluminium smelter in Congo.

The new Inga plan includes the creation of a catchment pool that will permit the construction of as many as six more plants, including Inga III, he said. Congo will choose a

developer from three groups of companies. The groups are made up of China Three Gorges Corp. and Sinohydro Corp.; Posco and Daewoo Corp. of South Korea in partnership with Canada's SNC-Lavalin Group Inc.; and Actividades de Construccion y Servicios SA, based in Madrid, and Spain's Eurofinsa Group which have submitted a third bid. Congo is being advised by US law firms Orrick, Herrington & Sutcliffe LLP, Lazard Ltd, Tractebel Energia SA of Brazil and GDF Suez of France.

Source: www.renewableenergyworld.com





# RENEWABLE ENERGY FROM THE OCEAN

## OFFSHORE WIND, TIDAL, WAVE, AND OTHER SOURCES

Just a tiny fraction of the energy that the world's oceans contain is enough to fulfil all our electricity needs. But how do we harness it? **Jyothi Mahalingam** provides some answers.

Climate change had been just a topic of discussion among a few scientists and environmental researchers at universities and research centres for several years. But since the last decade, the news of melting Arctic glaciers, rise in global temperatures, erratic rainfall, and unexpected drought conditions all over the world had increased awareness about climate change, even among commoners. Now, it has gained momentum to become a hot topic of discussion. Well known research institutions the world over have concluded that increased emission levels of greenhouse gases, such as nitrous oxide, carbon dioxide, fluorinated gases, methane, and other gases, are the reason for these climatic changes. It has been found that methane, with its higher level of heat trapping properties, heads the list. It contributed more to the recent changes in climate conditions than the others, and was closely followed by carbon dioxide.

Currently, scientists who work in research institutions all over the world are studying the effects of the rise in greenhouse gas (GHG) emission levels and consequent changes, such as

the increase in global temperatures and erratic climatic conditions. The environmental technologists are finding ways to generate clean energy to bring down GHG levels in the atmosphere, while policy-makers and legal experts are trying for legislative steps in order to give clean energy efforts stronger teeth to tackle the envisaged problems.

Efforts are on to introduce clean energy power generation facilities that leave behind the smallest possible environmental footprint and cut down pollution levels. The idea is to reduce the use of the existing GHG generating natural resources, such as petrol, diesel, coal, and so on, and trim down the harmful emission levels and wastes. The clean energy or renewable energy power generation facilities include biofuels, hydropower, solar power, biomass, and wind power (onshore and offshore) generation.

### Global Trends in Green Energy Investment

According to the Global Trends in Renewable Energy Investment 2013, a report published by the Frankfurt

School – UNEP Collaborating Centre for Climate and Sustainable Energy, global investments in clean energy stood at US\$ 244 billion. However, it was down by 12 per cent when compared to the investment of US\$ 279 billion in 2011, and up by 8 per cent when compared to the 2010 investment.

In the year 2012, Green energy investment saw a radical shift in the higher level of investment between developed and developing economies. The developed economies invested US\$ 132 billion with a 29 per cent reduction in investment when compared to the previous year, while developing countries increased their investment by 19 per cent and invested US\$ 112 billion. The downtrend faced by the dollar globally and the steep fall in technology prices are the major reasons for the sharp fall in clean energy investment.

Among countries that invested in clean energy technologies in 2012, China leads the table with US\$ 67 billion, and the USA follows next with US\$ 36 billion. The total investment in clean power generation does not include around US\$ 33 billion invested in hydroelectric power generation.

Globally, solar power leads the clean energy investment table as a major renewable energy generator and contributor. It is closely followed by wind and other clean energy technologies.

### Clean Power Generation from Oceans

The oceans that cover over 70 per cent of the earth's surface have always fascinated us. While their physical charm attracts us, scientists from all over the world are trying to explore and exploit their potentialities to produce electric energy. Researchers are looking forward to using the enormous kinetic energy of the oceans through various sources available in the form of offshore wind, tidal energy, waves, motions of undersea current, and other heat energy sources. Recently conducted research has estimated that if we tap even 0.1 per

cent of the available ocean energy, it can supply and meet nearly five times the global electric power requirement.

It is interesting to know that Girard, a French national, and his son had filed the first patent application to generate ocean wave power in 1799 at Paris. In the later years, it was the UK which took the lead and filed over 340 such patents from 1855 to 1973. A solid base for current research in exploiting ocean wave power was laid by Yoshio Masuda, a Japanese researcher, in 1940. His invention of generating power by changing the angles of joints in an articulated raft deployed at sea evoked much interest in the 1950s.

The oil crisis that took the world by storm in 1973 prompted scientists to review and restart their research into ocean power generation. Notable among the findings was 'Salter's Duck', also called the 'Edinburgh Duck', introduced by Stephen Salter, a researcher from the University of

Edinburgh. The instrument had the body shape of a curved cam. It was able to exploit 90 per cent of the wave motion and achieved 81 per cent efficiency by converting 90 per cent of such motion into power.

Though research continued, the drop in oil prices in the 1980s saw a drastic reduction in the financial support for such research. However, the trial test results of some of the prototypes of the first versions sustained the interest in alternative power generation. The growing concerns about global warming and climate change had necessitated the increased use of renewable energy sources through the development of new alternatives. This gave a new lease of life to ocean energy research. Currently, efforts are on to generate clean power from ocean power sources, such as offshore wind, tidal power, waves, and so on.



### Offshore Wind Power Generation

Among the available ocean-centric clean power generation facilities, offshore wind power productions lead the table. The offshore wind farms were the first to go beyond the research level and be deployed for commercial power generation. Also, the limitations in installing inland wind power generation facilities fuelled the growth of offshore installations. Presently, the offshore installations offer nearly 4,000 fully operational hours in a year, thus making them more production-competitive than the inland installations.

### Challenges in Offshore Wind Power Generation

Higher level of investment cost is an important element that plays a crucial role in the growth of offshore wind power generation. The perception of the consumers in the continuation of subsidies to green energy generation also plays a decisive role in cutting down the costs. The contractors as well as original equipment manufacturers (OEMs) fear that such a move will increase the turbine and construction costs.

The turbines installed and used in intimidating operating conditions need to withstand the salty weather environment. The turbine foundation installation, the substructure to hold balance-of-system, interconnecting the turbines, and connecting the generated power to the land facility need substantial investment. Unlike the land-installed wind power generation facilities, offshore-based installations additionally require special handling facilities at the port and unique vessels for transporting the wind turbine mast, blade and other parts to the offshore locations, as well as offshore assembling and installing facilities. Also, the higher level of risks involved in completing such installations causes concerns to investors.

Another worry that disturbs the investors of offshore power generation is the 'supply chain management' risks. In spite of being a subject of active discourse, there is a dearth in the experience required to manage projects in offshore wind power generation. The most important sea ports used to manage the supply to the installations are invariably crowded and do not have enough engineering infrastructure to manage the demand. Also, the limited number of offshore installation vessels further

delays the projects. The existing ambiguous agreements in the subsidy arrangement between the offshore power-generation industry and the government also worry the investors. They are also troubled by the present bottlenecks in getting efficient grid access to transmit the generated power.

### Encouraging Factors

According to a recent report titled Offshore Wind Toward 2020 from Roland Berger — though the offshore wind power generation may not match the growth of its inland counterpart — offshore power generation is definitely growing at a rapid pace and is expected to reach the 130 billion global mark in value by the year 2020. It is also expected that it will become more cost competitive in the coming years.

Offshore wind power generation has come a long way since its infancy. It has blossomed to perform creditably in large-scale power generation installations. When compared to a land-based wind power generation facility, the offshore installation offers nearly 1.5 times more energy yield. Its vast power generation potential remains only partially tapped. Currently,



efforts are on to build bigger-sized, utility-scale offshore power generation facilities.

In a new survey conducted by PWC, most respondents indicated that offshore wind power generation will play an important role in the energy generation mix in the next 20 years. The survey also pointed out that the technological innovations in the offshore wind turbine production and installation will play a stellar role in the reduction of power generation costs. This relatively young technology has the potential for further research for cost reduction.

### Worldwide Offshore Wind Power Installation and Generation

On 12 October, 1991, the world's first-ever offshore wind farm, a 5 MW power generation facility, started its operations. The eleven turbine wind farm installed close to Vindeby on Lolland in Denmark is still generating power and contributing towards cleaner energy generation.

Globally, Europe leads the offshore power generation industry, with

nearly 90 per cent of the world's installations situated on the shorelines of Denmark, Belgium, Germany, and the UK. According to the Global Wind Energy Council Report, based on its findings in 2012, the United Kingdom leads offshore installation with 2,947.9 MW capacity, followed by Denmark with 921.1 MW, China with 389.6 MW, Belgium with 379.5 MW, Germany with 280.3 MW, the Netherlands with 246.8 MW, Sweden with 163.7 MW, and other countries, namely, Ireland, Japan, Norway, and Portugal with a total of 86.1 MW.

The European Union (EU) is looking forward to generating 35 per cent of its overall energy requirement by deploying renewable energy sources by the year 2020. This includes its proposal to draw 12 per cent of the required power from the proposed 40 GW offshore power production facilities. Presently, the EU has 5 GW installed capabilities which sometimes exceed the expected actual yield.

In 2012, among the countries in the Asia-Pacific region, China demonstrated a production capability of 258 MW. Japan, which now generates

25 MW, has made a quick proposal to install a floating power generation facility of 16 MW close to the coast of Fukushima. China is planning to add 5,000 MW offshore power generation capabilities by the year 2015, and raise it to 30,000 MW by 2020. South Korea is currently at its planning stage to produce 2,500 MW offshore wind power around 2019.

It is a surprising fact that countries, such as the USA and Canada, despite being leaders in onshore power generation, are yet to have a single offshore wind installation. In fact in the fourth quarter of 2012, the USA has shown a cumulative installed capacity 60,007 MW onshore wind power generation, closely following the leader China. Currently, the USA has announced its plans to install 23,865 MW offshore wind power generation capacity, and Canada has plans to install 1,750 MW offshore power generation facility to start with. According to the PricewaterhouseCoopers (PwC) report, the USA has shown its strong desire to have 54 GW of installed offshore power generation facility by the year 2030.



The other countries that have announced their intention to start offshore wind power generation facilities include Albania, Egypt, Estonia, France, Malta, Poland, Romania, Hong Kong, and Taiwan.

### Typical Offshore Project Development

At present, it takes nearly 7–10 years to develop an offshore wind project. It is anticipated that in the coming years the gained expertise in such installations will cut down the development period.

#### Planning Stage

Identifying a suitable site for offshore wind farms is very important. Normally, the areas that are close to bigger bays or harbours, and narrow straits with increased levels of marine current are found suitable for installation of offshore wind farms. After choosing the site, its wind potential at different heights is evaluated. In order to collect details on wind direction and its speed, sensors are used. Anemometers are deployed to track the weather at the site.

#### Permission Stage

On receiving the application for a wind farm installation, the authorities conduct the necessary environmental studies and then grant permission.

#### Managing Supply

The manufacturer and product suppliers are selected and the

supply and payment terms are negotiated with them. Interface risks are identified and apportioned. The details on installation and managing other logistics are developed, and finally Operations and Maintenance (O&M) is formulated.

#### Arranging Finance

The project structure is fine-tuned for the details. An all-inclusive financial model is prepared to approach the financial institutions. The terms of project finance are finalized and the agreement is signed.

#### Construction and Commissioning

Discussions are held with the suppliers to set the time-frames to make supplies of turbine parts that will match the logistical arrangements envisaged. Interface risks are identified in advance to minimize them. The project is managed efficiently to facilitate timely commissioning.

#### Operations and Maintenance (O&M)

Normally, a cost-effective operations and maintenance (O&M) model will be chosen for the last and most important stage in offshore wind power generation. Only proper O&M assures and increases the turbine availability for optimal use and enhances the level of power generation. Effective O&M also assists in an immediate change of required components when needed, followed

by quicker problem solving services, thus reducing the downtime at the facility.

### Construction Stage of Offshore Development

Selecting a proper foundation plays a vital role in offshore wind power development. Presently, foundation models such as Gravity-based foundations, Monopile, Tripod/Pile, Jacket, and Floating foundations are in use.

#### Gravity-based Foundations

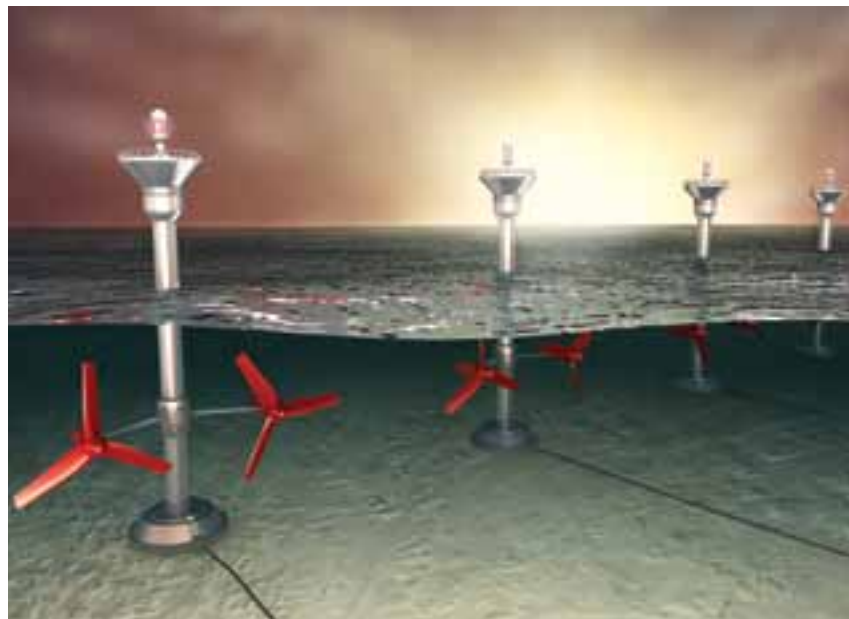
These foundations are normally used in places with shallow water that are less than 20 metres in depth. The newly developed Gravity-based Formulations (GBF) concepts come with the possibility of extending the depth up to 40 metres.

#### Monopile Foundations

For shallow water depths from 10 to 25 metres, Monopile foundation is employed. This foundation is presently deployed in over 75 per cent of the offshore developments. The foundation is constantly undergoing changes to overcome its weight and other constraints in deep-water installations.

#### Tripod/Pile Foundations

These foundations are usually used in 25–50-metre depth conditions. But the highly complicated structure of the foundation and increased level



of weight limit the use of both these types of foundations.

#### Jacket Foundations

These low-weight foundations are deployed in water depths ranging from 20 to 60 metres. The flexibility in completing the foundation erection and its reduced weight due to a smaller quantity of steel used increases the demand for its deployment.

#### Floating Foundations

Floating foundations, which can be deployed in water depths beyond 60 metres, are still undergoing changes. The full-fledged commercial use of such foundations may become viable only after 2020. Floating foundations are suitable for countries that suffer from steep offshore lines.

#### High Voltage Direct Current Connectivity

In order to link all the wind turbines installed at the wind farm and to transfer the generated power to the grid, High Voltage Direct Current Connectivity (HVDC) cables are used. The transformers are used to amplify the voltage power of each wind turbine.

Substations weighing over 500 tonnes with a backup power generator are constructed at the site, with a facility to accommodate a few workers. These substations will also have a fuel tank, switch gear, and voltage transformers.

Presently, only three companies — ABB, Siemens, and Alstom — are engaged in the manufacture of converter stations, and each takes around 30 to 50 months to supply them. Also, the number of ships with the capability to install converter stations weighing over 10,000 tonnes are very few, causing delays. Similarly, only a few companies supply the cables and chances of shortage are more.

#### Grid Access

One of the major issues that still haunt offshore wind power generation is proper grid access. Grid access includes linking the generated power from the offshore locations to the grid and then transferring this power to the consumers. A consensus on who (the developer or the government) will bear the cost of connecting the generated power to the grid has not yet been reached. At present, the generated power is distributed only

to the consumers located close to the shore lines and the infrastructure for transferring the power to far-off inland locations is yet to be developed fully. Also, the existing grid systems need to be upgraded with smart-grid management features to manage the vagaries of offshore wind power generation.

#### Typical Structure of an Offshore Wind Turbine

The structure of an offshore wind turbine is like that of an onshore wind turbine. Offshore wind turbines are sturdily built using special material and paint applications to withstand the tough offshore weather conditions. They usually have a power generation range between 2 MW and 10 MW. A typical turbine will have a tower, nacelle, hub, and blades.

The turbine tower is erected over the chosen type of foundation. The tower includes the turbine along with its rotor, which includes the blades and the hub. Most present-day offshore turbines have a height of 70–90 metres over the installed foundation. The nacelle of the turbine incorporates a mainframe and a covered portion for the gearbox, generator, and the brake. The blades of the turbine are made of reinforced plastic to withstand high wind velocity at offshore locations and the installed gearbox controls its speed.

In order to transfer the power to the offshore substations and further, all the wind turbines placed in an offshore farm are interconnected to each other.

#### Wind Turbine Manufacturers

The offshore wind turbine manufacturing industry is dominated by Siemens, and closely followed by Vestas. Other notable names include GE, AREVA, REPower, Alstom, Sinove, IBard, XEMC, Gamesa, and others.

#### Environmental Issues Related to Offshore Installations

Environmental studies conducted at offshore wind installations found that the offshore wind farms cause fewer disturbances to the environment than the onshore installations. It was also found that they create no impact for the biodiversity in the area. In fact such installations positively allowed the development of a range of undersea organisms, such as mussels, anemones, and others.

#### Tidal Power Generation

Tidal power is another kind of ocean energy that looks very promising. It is a form of kinetic energy which is induced by the surge of ocean waters due to the gravitational pull of the sun and the moon over the earth. Though power generation using tidal energy is still in its nascent stage, the certainty and regularity in the occurrence of the ocean tides make tidal power generation more practical and promising. Unlike solar and wind power generation facilities that are affected by solar eclipses and vagaries of the wind, tidal power generation is constant, and does not need a fossil fuel powered backup facility to manage uninterrupted power connectivity to the grid.

#### Tidal Power Technology Categories

The tidal energy power generation technology is broadly categorized into two dissimilar types utilizing two different kinds of energy — potential and kinetic.

##### Potential Energy

The first one, known as potential energy, uses the variation in water level due to tides. Tidal barrage or tidal dams are presently constructed at places where the tide potential is

more. During high level when sea level rises, the tidal water rushing inland is canalized into a large-sized ridge of land and stored in the barrage. When the tide recedes, the water stored at higher levels behind the barrage is released and passed through sluices. This water is directed at the installed turbines to generate electric power. Tidal dams, La Rance in France and Annapolis Royal in Canada, are existing examples that use the potential energy power generation method.

##### Kinetic Energy

The second one, known as kinetic energy technology, uses running water to run the installed tidal stream generators or turbines to generate power. The technology is comparable to that of wind power generation. Such kinetic energy generation facilities can be constructed on existing bridges without causing any visual obstructions.

##### Dynamic Tidal Power

Another technology that is still under the early stages of consideration is dynamic tidal power. The projected technology will combine both the potential and kinetic energy generation capabilities of tidal power. The envisaged technology proposes

to construct very long dams of 30–50 km in length from the coast into the ocean without actually covering the area. The technology will introduce a considerable level of difference in water level between the two sides to exploit the tidal current potential and generate power. The technology is found more suitable for coastal locations in South Korea, China, and the UK.

#### Ideal Site to Generate Tidal Energy

Tides are commonly found over coastlines in almost all parts of the world, but not all such locations are suitable for power generation. An ideal tide power generation facility needs to be located in a bay inlet or a narrow channel with a significant volume of tidal water flow. Such a place should also have adequate depth to support production, and a flat profile to build a tidal dam. Locations close to the shoreline are preferred for easy maintenance and repairs and for uncomplicated connectivity to a power distribution network. Such shorelines should have a tide height of at least 7 metres for economically viable operation, and have enough water to run the turbines.





## Tidal Turbines

Similar to onshore or offshore wind turbines, tidal power turbines also deploy blades that rotate and generate power. Unlike wind turbines that use bigger blades to draw more wind and generate more power, tidal turbine blades are smaller in size. They are designed compactly to withstand the powerful flow of water that is nearly 832 times denser than air.

The installation of turbines for use in tidal streams is a little more intricate. They must be located in places that cause less environmental impact, especially on marine life. In order to extract the best output from such installations, the turbines are placed in shallow waters. Also, such placement assists in the normal navigation of ships, and the slow turning turbine blades reduce the impact on marine life.

### Typical Tidal Turbine

Typically, tidal turbines have axial-flow rotors that use a gearbox to drive the generator, comparable to that of the rotors deployed in a wind turbine or a hydroelectric turbine. The pitch-controlled rotors of the turbine enable it to gather more tidal energy and cut down the intensity of forces that damage its structure. The blades are placed over the top third of the water level where the tidal flow is tested as fastest. The electrical infrastructure, incorporated in the support structure of the turbine, enables it to generate grid compliant power, thus doing away with the need for an external power controller. To assist easy maintenance, the support structures that assist the turbines can be taken out of the water.

### Cost of Construction

The biggest deterrent in the growth of tidal power generation is its construction costs. The high level of capital investment and long

construction period of upto 10 years escalates the cost of power generation and makes it depend heavily on government subsidies. Major elements that influence the cost include the efficiency of the site, and the size (length x height) of the barrage construction. The height of the constructed barrage and its variation in height during high and low tides determines the efficiency. Such efficiency is calculated using the 'Gibrat' ratio which uses the length of the barrage in metres and its yearly power production capability in kilowatt-hours. An ideal cost economy site will have only a minimum Gibrat ratio level.

The tidal power generators are found to have comparatively low levels of investment because they use an existing technology and do not need special power transmission methods to transfer the generated power to the land-located power grid.

### Countries having Tidal Power Generation Facilities

The countries that either have a full-fledged tidal power generation facility or are on the way to having one include France, South Korea, Mexico, China, Canada, Ireland, India, the USA, and the UK. Among them, France boasts of the oldest running facility, and South Korea has the largest facility among the existing facilities.

### Tidal Power Generation Potential

According to Marine Current Turbines, a Siemens business company, tidal power generation has the potential to produce around 800 terawatt-hours (TWh) of electricity per year. Such power generation is enough to power around 250 million households all over the world with clean power. The UK, believed to have the biggest marine energy potential globally, is likely to

generate over 10 GW, that is, around 50 per cent of the projected tidal power capability of Europe.

### Tidal Turbine Manufacturers

Marine Current Turbines Ltd (MCT), owned by the Ocean Hydro Division of Siemens, with over 20 years of exposure with the technology, leads the field. The other companies engaged in tidal turbine manufacturing include Alstom, Bourne Energy, Clean Current Power Systems, Rotech Holdings Ltd, Open Hydro Group, ANDRITZ HYDRO Hammerfest, Tocardo International BV, Tidal Generation, Clean Energy BC, and DynaVec AS, among others.

### Environmental Impacts

The biggest problem faced by barrage or tidal dams is the formation of silt. The accumulation of silt will slow down movement of the tide and cut down the potential to hold large quantities of water. The accumulation of silt also cuts down the reach of the tide. Such scaling down in the reach of the tide also impacts the bird population.

The underwater running turbines pose dangers to marine life. Though present-day turbines are designed for lower speed with enough gaps between the turbine blades for easy escape of sea mammals, they continue to pose a threat to their lives. Also, the running of the cables from the turbine and the other floating facilities used displace the birds and sea creatures from the area.

### Wave Energy

Among the available ocean energy generation opportunities, wave energy continues to remain untapped, although it can have a major share in the ocean power generation mix. Unlike solar and wind power generation, wave energy is more predictable and consistent

in nature, and offers the advantage of increased power generation. It is estimated that even with the existing technology, wave energy has the potential to generate 140 to 750 TWh of power every year.

Wave energy power generation, which is still in its embryonic stage, suffers from the prohibitive cost of power generation. Its cost of power production per MWh is nearly three times that of coal power generation, and 1.5 times more than wind energy generation. To cut down this cost difference, researchers are engaged in understanding the characteristics of waves to find their potential in advance. Such prediction will assure the investors the possibilities of cutting down power generation costs.

### Wave Energy Converter

The Wave Energy Converter (WEC) plays an important role in wave power generation. A number of such devices have been tried out in extracting wave energy offshore, onshore, and from places near the shore locations. The WEC will include facilities to capture wave power and transfer this captured power to the power generator, as well as a power capturing and transferring technical feature. Based on these operating principles, the WECs are generally classified into four groups.

#### Oscillating Water Column

The technology uses a partly submersed compartment-like arrangement, where the entering waves of water form a column, and similarly entrapped air forms another column. The continuous change in water levels due to incoming wave water makes the trapped air expand and compress, which in turn makes the turbine located inside the chamber run and generate a steady level of energy.

#### Overtopping Device

The device uses a central reservoir to seize and store gushing sea water and discharge it towards the sea using a number of hydroelectric turbines installed within it. Such movement of water makes the turbines run and generate power.

#### Attenuators

These long, constructed floating devices are made of multi-segments, and placed in such a way as to face the incoming waves. The flexible segments, connected by hinged joints, are propelled with the movement of waves and make mechanical motions. Each such movement of the flexing is transformed into electrical energy.

#### Point Absorbers

These are small instruments with limited power generation capabilities. They draw wave energy from all directions to convert it into power. The power generation capacity of each unit in such installations ranges from 70 kW to a couple of MWs and a number of such units are assembled to form a wave energy farm.

The predictability of wave energy power generation makes it more grid-friendly. In order to transfer the power generated from the deployed WECs or the WEC farm, electrical infrastructure equipment, such as substations, transformers, and switches are used. While it is possible to standardize the use of equipment and install smart grid features to manage fluctuations, keeping the installed WECs informed about the type of waves they may face alone determines the quantity and quality of power generated from them.

### Ocean Thermal Energy

Another form of energy that can be generated from the ocean is thermal energy. The Ocean Thermal Energy Conversion (OTEC) technology will use the difference in temperature between

the cool deep water and warmer surface level water. The difference between the two water levels is more in tropical locations, where the warm water can be used to change a liquefied substance such as ammonia into steam. Such generated steam is used to run a turbine and produce power. The liquefied ammonia is then condensed using cooler water pumped from the ocean's depths. The process is repeated to produce power continuously.

Presently, Reignwood Group, a resort-developing company based in Beijing, China, and Lockheed Martin have signed an accord to develop a 10 MW plant that deploys ocean thermal energy conversion technology. The construction of this facility is to be done at a location away from Hainan Island in southern China.

The environmental impact of sucking cool water from ocean depths is still being probed. Though small in number, OTECs are functioning in various parts of the world; the higher level of investment required restricts its growth further.

### Conclusion

Other than the offshore wind power generation, the potential of other ocean power generation technologies, such as tidal, wave, and ocean thermal energy are yet to be tested and used commercially. Though they hold potential for growth, they are still at the development stage. The biggest factor that hampers the exploitation of ocean power for renewable energy generation is the massive investment needed for the development. The government's willingness to encourage such technologies in the form of subsidies and introduction of suitable legislations to speed up the installation will help their growth. It is hoped that the continuing research will help in realizing this dream in the days to come. ■



# GOING GREEN

## Renewable Energy Initiatives in Latin America

The Latin American region is a storehouse of renewable sources of power, but economic and political instability has meant that this potential has not been fully explored. However, **Tejal Heblekar** finds that there is light at the end of the tunnel.

When one thinks of Latin America, one sees breathtakingly beautiful natural landscapes. One sees great mountains, bountiful seas, rich rainforests, sun-kissed beaches, and deep rivers. While this looks good on a tourism brochure, it has more appeal in the energy sector. All of Latin America's natural beauty holds potential for making it a leader in producing renewable energy. Whether its wind, hydro, geothermal, solar, or biomass, these countries have the resources at their disposal to provide reliable energy supply to their citizens. However, there has been an absence of adequate energy security in these states. This was demonstrated in the energy rationing that was undertaken in Brazil and Venezuela in 2001–02 and 2004, respectively. Now, with the global pressure on fossil fuels increasing each year,



developing countries need to invest more in renewable energy initiatives. This is especially true of Latin American countries. Home to several emerging economies, the region's energy demand, as predicted by the International Energy Agency, is set to increase by 50 per cent by the year 2030. The agency's report further asserts that in the next decade there will be a need to increase generation capacity by 26 per cent in order to meet the estimated 6 per cent annual growth rate

in the region. To meet these demands, Latin American governments will have to look beyond their depleting oil and other fossil fuel reserves.

Economic growth aside, the region also faces the pressing issue of climate change and the extreme and, often, disastrous conditions it fosters. One of the main challenges these countries have is that of eliminating their carbon footprints. According to the report, The Climate and Development Challenge for Latin America and the Caribbean,

Latin America would need to invest US\$ 66 billion annually to reduce their carbon output. The report, which is a joint effort of the Inter-American Development Bank, the World Wide Fund, and the Economic Commission of Latin America and the Caribbean, further states that over half of the money will have to be invested in renewable energy initiatives.

For Latin American countries to achieve this goal, global financial investment has to be free-flowing. The year 2012 saw a major worldwide decline in new investments in clean energy initiatives. According to Bloomberg New Energy Finance (BNEF), the rate of investment fell 11 per cent, from US\$ 302.32 billion in 2011 to US\$ 268.69 billion in 2012. However, the BNEF also says that investment in renewable energy projects in Latin America grew substantially. Last year alone, the







region saw an investment of US\$ 4.6 billion in clean energy initiatives. In particular, the BNEF cites four countries — Mexico, Chile, Peru, and Uruguay — where the investment increase was remarkable. For instance, in Mexico, new financial investments grew 595 per cent to US\$ 1.9 billion in 2012.

The global financial meltdown and improved geo-political conditions in Latin America have, it seems, opened up new possibilities for renewable energy initiatives in the region. Emphasizing the region's emerging importance in the clean energy sector is the Renewable Energy Finance Forum — Latin America and Caribbean (REFF-LAC), which is an annual conference that focuses on new investment opportunities in renewable energy projects. This year, the focus was more on encouraging investment in sustainable energy initiatives in the region.

With such a promising outlook, the Latin American region is surely a welcome relief for clean energy enterprises. But what about the region's track record of working with renewables? This is probably an important question that will be playing on most of their minds. As per a report by the Worldwatch Institute, even with plenty of wind, solar, and biomass resources, many Latin American countries are reverting to fossil fuels for generating energy. It gives the example of the Dominican Republic, where in spite of wind farms and plans for a solar power plant, the government announced the development of a coal-generated power plant to meet the country's growing energy demands. This rings true for most of Latin America, where solar and wind technology has not been received with as much enthusiasm as geothermal or hydropower. According to the Global

Wind Energy Council, the region has only 1.3 per cent of global wind power capacity and the percentage is even lower for solar energy.

Globally, the most exploited renewable energy source is hydropower. In Latin America alone, it accounts for about 65 per cent of total power generation. In 2010, the region boasted of 153 GW of total installed hydropower capacity. In this regard, Latin America stands out as the leader, with the world average for hydropower generation being a paltry 16 per cent. It is no surprise then that one of the world's largest hydro projects, with a capacity of 14 GW, is the Itaipu dam in Brazil. While large-scale hydro projects are not sustainable in all of Latin America, ICSU and CONACYT estimates in Sustainable Energy in Latin America and the Caribbean: Potential for the Future show that the region has total hydropower potential of 659,531 MW,

of which only about 21 per cent is being used.

It is necessary for the region to look at small-scale or micro hydropower projects to ensure sustainable and reliable energy supply for its population. According to the Renewable Energy Country Profiles: Latin America by IRENA, several countries in the region have made plans for small hydropower initiatives. For instance, as per the report, Argentina plans to develop 10 hydro projects, with capacity for generating 26 MW. Chile, on the other hand, has announced 30 hydropower projects with capacity for 385 MW. There's promising news also from Colombia, which has announced two small hydro projects of 20 MW by the end of 2014.

Another sustainable renewable power source in the region is geothermal energy. What makes Latin America and some parts of the Caribbean ideal for geothermal energy production is the highly active volcanic west coast. From Mexico to Chile, there are several locations from where geothermal energy can be harnessed. Latin American countries have strong potential for generating power from this renewable resource. It is estimated that Chile can generate about 16,000 MW of geothermal power. Chile has rich geothermal resources because of the 4,270 km long, volcanically active Andes mountain range that stretches along the country's length. However, progress in harnessing this source of clean energy is slow, and the country

is yet to produce any electricity from it. There is hope though, with the Chilean government encouraging geothermal energy exploration through concessions. In 2012, the country received investments amounting to US\$ 250 million from foreign firms for about 20 such explorations. Argentina offers a feed-in tariff plan that is valid for 15 years after a geothermal plant goes online. The country also launched the Genren Programme in 2009, which aimed to acquire and utilize 1,000 MW from renewable energy plants, out of which 30 MW could come from geothermal sources. Other countries in the region that have taken geothermal energy initiatives are Costa Rica, El Salvador, Guatemala, and Peru.





Wind energy is also growing as a potential renewable resource in the region. As an alternative source for generating power, wind has shown consistent growth as a reliable option. According to BNamericas, in 2010 there was an increase of 50 per cent in installed generating capacity in Latin America, which took the total capacity to around 2,000 MW. Brazil was, undoubtedly, the leader in taking wind energy initiatives. As per the IRENA Renewable Energy Country Profiles, the Brazilian government's programme, the 'Incentives for Alternative Electric Power Sources' (PROINFA), boosted the development of wind-generated power. There are plans to develop

37 wind energy projects with 1,050 MW capacity by 2014, and 625 projects of 20,500 MW capacity that are announced.

Uruguay, on the other hand, aims to depend 100 per cent on renewable sources for generating power by 2030, out of which 30 per cent will come from wind energy. In keeping with its aim, the country had 44 MW of installed capacity in four wind farms at the end of 2012. The wind energy industry in Uruguay, according to its energy ministry, saw about US\$ 100 million in investment very recently. Argentina is another Latin American country with promising wind energy potential. According to BNamericas, about 75 per cent of

the country's land area 'experiences strong winds and is appropriate for wind power generation'. However, a lack of supportive government policy and financial stability seem to have arrested the industry's development. In 2011, Argentina had only about 79 MW of online wind power.

Besides wind, solar power is another abundantly available source of energy in Latin America. The generous sunshine in the region can be a great opportunity for the Latin American countries to meet their growing energy demands. Through grid-connected photovoltaic systems, governments can ensure that power reaches remote areas, and thus

strengthen national energy security. However, there has been limited use of this renewable resource in the region. In Roger Tissot's Latin America's Energy Future, he writes that as of now only about 4 per cent of the region's energy comes from solar power. Nonetheless, there is potential for growth, with Latin America emerging in the recent years as a promising market for solar power technologies. It is estimated by Greentech Media Research that in 2013 more than 450 MW of grid-connected solar photovoltaic systems will be installed in the region. This installation capacity is predicted to increase to 5.7 GW by 2017.

Among the top players for solar energy initiatives are Chile, Mexico, and Brazil. The Chilean government declared in 2011 that by the year 2020 the country would be producing 20 per cent of its power from renewable resources. In a move towards this goal, Chile has encouraged the development of projects such as Atacama Solar, which is a US\$ 773 million, 250 MW PV initiative, that could be the world's largest power generation plant. In Mexico, the solar energy industry is on a gradual rise. Northern Mexico, it is believed, has the world's third largest solar insolation, with some areas receiving about 4.5 kWh/m<sup>2</sup> per day. In 2012, the Mexican government passed a law that dictates that by 2024, 35 per cent of the country's electricity would be generated by renewable sources. To achieve this aim, the government has offered tax incentives and welcomed foreign investment in numerous solar projects. A leader in wind power, Brazil, it seems, has also stepped up to the plate in the solar energy sector. Ahead of the FIFA World Cup of 2014, the country plans to build solar-powered stadiums, such as the Estádio Governador Magalhães Pinto in Belo Horizonte. It is estimated that the stadium that will host the final match will be powered by about







# ENERGY CRISIS

The world is approaching an energy crisis which will slow down the global economy even further. **Bashobi Banerjee** explores the problem and possible solutions.

Energy is closely linked to the economic prosperity of any nation. Its demand is increasing due to the advent of urbanization, climate change, and global warming, in that order. Scientists have predicted that there will be an energy crisis sometime in the 21st century. And given the rate at which we are exhausting the world's natural reserves — coal, natural gas, and crude oil — their prediction stands somewhat true; we will surely run out of these valuable sources of energy. Due to this imminent crisis in the near future, our existence will be seriously affected.

Fossil fuels, mainly coal, petroleum, and natural gas, provide more than 85 per cent of the energy used today. The energy crisis of the 1970s is not hidden from anyone, and the threat of a future crisis looms large. Our current dependence upon fossil fuels is untenable. The United States of America, having just 6 per cent of the world's total population, consumed around 30 per cent of the energy produced in the world during the second half of the 20th century. The demand for petroleum is ever increasing. The invasion of Iraq 10 years back is testimony to this. Besides,

the nations responsible for supplying fuel to the rest of the world are already feeling the heat themselves. Following the Fukushima nuclear disaster in 2011, Germany has permanently shut down eight of its nuclear reactors and will close the rest of them by 2022, with Switzerland and Spain banning the construction of new nuclear reactors. In Britain, 7 GW capacity is lost as five coal-fired power stations are closed because of their inability to check their pollution levels to comply with the EU Large Combustion Plant Directive of 2001. This has led to the depletion of 10 per cent of the assumed availability



1,500 solar panels. The country's new net-metering legislation, and the fact that solar energy has become cheaper than grid electricity, means more solar energy initiatives in the future.

A controversial option that many Latin American countries are considering as an alternative energy source is biomass. Biodiesel or biofuel, which is derived from biomass, has received much criticism over the years for its credibility as a sustainable option. Critics argue that the cost of production, which includes the economic as well as ecological calculations, is much higher than biofuel's value as a renewable energy source. Nonetheless, countries such as Brazil, Chile, Argentina, Bolivia, Colombia, Ecuador, and many others have made plans for using biomass as a major source of energy. For example,

the Brazilian Ministry of Mines and Energy predicts that by the year 2020 power generated from biomass will reach an installed capacity of 20.1 GW, accounting for 11 per cent of total installed capacity.

In Argentina, the production of biodiesel receives government tax incentives. There is tax of only 5 per cent on the sale of biodiesel, for instance, of which 2.5 per cent is refundable as tax credit, as per the Sustainable Energy in Latin America and the Caribbean: Potential for the Future published by ICSU and CONACYT. The joint study by ICSU and CONACYT stipulates that while some countries in the region have 'made important advances toward establishing a regulatory framework for biofuels', there is a need for 'governments and regional

institutions' to 'coordinate and facilitate investment and research'.

With such a varied array of renewable resources, Latin American countries seem to be spoilt for choice in their options for sustainably generating energy. However, the lack of financial stability and supportive government policies across the region has meant slow progress in realizing the dream of clean energy production. There is hope on the horizon, though, with the in-flow of foreign investment in sustainable energy projects, and some countries offering incentives for the same. Whether this will lead to a boost in renewable energy initiatives in the region is something that keen eyes and ears will be waiting to hear. ■



### Depleting Energy Sources

A few sources of energy which will eventually drain out due to over-exploitation in the near future:

1. **Oil:** Fossil fuel, so non-renewable; most widely used energy source today (constitutes almost 40 per cent of primary energy supplies).
2. **Gas:** Fossil fuel, so non-renewable, and will be exhausted soon!
3. **Coal:** Fossil fuel, hence non-renewable; has become less important in Europe but growing

rapidly in emerging economies, such as China and India.

4. **Oil shale:** Fossil fuel, so non-renewable; not worth exploiting at present energy prices.
5. **Tar sands:** Fossil fuel, so non-renewable; Venezuela and Canada are rich in these resources, though showing signs of exhaustion.
6. **Wood:** Non-renewable; will cause a potential threat at the rate of its rapid consumption.

of electricity sources; further, one more coal power station is supposed to shut down by 2015.

The future energy crisis will neither be a geologic crisis nor a strategic one; it will be more of a 'slow growth' crisis. Even though the oil industry worldwide is figuring out a strategy to

recover huge supplies of oil, the cost, nonetheless, will be overwhelming! In the decades to come, conventional oil, which may now cost US\$ 4–6 per barrel to lift out of a Saudi Arabian well, may cost more than US\$ 100 per barrel to lift out of deep water deposits off the coast of Brazil. And these costs will only

go up, as each barrel of oil will become more expensive to recover.

The energy crisis is seriously affecting most of the industrial world. Countries such as France, Germany, Japan, Italy, Israel, Portugal, and Spain are dependent upon external sources for most of their energy sources, more specifically oil, especially the island nation of Japan which is highly industrialized but has limited energy resources. On the other side of the globe, France, western Germany, Italy, Portugal, Spain, and Great Britain do not have any appreciable amounts of fuel resources. Israel is surrounded by hostile neighbours who have fuel resources but would certainly not share them. Canada though is well supplied for her own needs. In the eastern part of Europe, Russia is supposedly well equipped too. For Mexico, it is very cheap to import American natural gas as compared to Asian countries, such



as China, due to Mexico's advantageous location in terms of close proximity to America. The third world regions like South America, Africa, and Asia are, however, being caught short by the rising fuel prices as they struggle for sustainable development. It has been said that energy use the world over has been increasing by 2 per cent annually for decades, while supply is unable to follow suit. Petroleum production appears to have peaked, while renewable replacements, such as solar energy and wind energy are not growing fast enough to replace and meet the increased demand. Studies show that a major energy shortage and much increased costs are on the horizon in the next 20–30 years. According to sceptics, although solar and wind energy are practical and non-polluting, however, as they are at an experimental stage only, they will not be as cost-competitive as the

energy derived from non-renewables, such as fossil fuels (gas and coal). Also, in the near future, petroleum supplies will shrink further, and costs will consequently increase. A sense of energy starvation will haunt all of us. Thus, in this scenario, alternate sources of energy are the need of the hour and need to be extensively explored and researched to enhance their cost-competitiveness as compared to fossil fuels.

### Attempting a Transformation to Post-Petroleum Sustainability

Now that we know that alternative sources of energy are the hope to our future, let us throw light on each source and its availability in order to tackle the situation of an energy crisis in the future.

**Solar:** We all know that solar energy is derived from the sun, and that it can

be used as an inexhaustible supply of energy. However, harnessing solar energy comes with its own set of problems. The problem begins with storage of energy so we would have power at night or on cloudy days. Also, currently the cost of energy generation through solar technology is considerably high. Hopefully, in the near future there will be some breakthrough in this aspect.

**Geothermal:** This non-renewable alternative source of energy uses the earth's own heat. Most of its consumption is in the form of geothermal heat pumps the world over. However, it does not seem likely that this source would be worth exploiting due to its high cost and other problems, such as high percentage of geothermal heat pumps with low capacity factor.

**Tidal:** This source would harness the ocean's tides, but except in isolated instances, it would not appreciably





affect our future energy requirement. **Wind:** For years together, windmills have been a source of power. However, for future consumption, wind energy is only worth it if wind farms are built in locations that have strong, steady winds.

According to the International Energy Outlook 2011 Reference case, the world's marketed energy consumption will grow by 53 per cent between 2008 and 2035. An energy crisis like this often affects the rest of the economy, with many recessions being caused by an energy crisis in some form. In particular, the production costs of electricity rise as a result, which raises manufacturing costs.

For the consumer, the price of gasoline (petrol) and diesel for cars

and other vehicles increases, leading to reduced consumer confidence and spending, higher transportation costs, and general price rise.

As discussed, about 60 per cent of all the energy used in the world today comes from oil and natural gas. Despite massive exploration programmes, very few large oilfields have been found in recent years. This means that most of the world's oil has been already discovered and exhausted (or is near depletion), and that in the future, oil reserves may be exhausted soon. Though today we feel that the world is producing enough oil to meet its present needs, our requirement is increasing and supply will be unable to meet this growth. If only we could use oil at the present rate, then the

world's reserves could last for a century. Unfortunately, the world's energy demand has been growing steadily over the past 50 years, and most experts believe that this trend will obviously continue in the absence of legitimate substitutes in the form of renewable sources of energy. One can then only assume how much energy will cost in the future and how much energy will be needed in the wake of an energy crisis.

### Conclusion

The real (future) energy crisis imposes a vicious cycle of higher structural petroleum costs, slower economic growth, and the lack of investment capital for alternate fuel technologies.



As a consequence, as petroleum costs hyper-inflate, the economy will become slow as consumers compensate by using less energy. This lowers the demand for oil, which depresses its price, which in turn slows investment in alternate fuel technologies for future use. The result is a hyper-inflation of

energy costs as the fixed, structural cost of petroleum spirals ever higher. As more and more resources must be invested in petroleum production, fewer and fewer resources will be available for other productive parts of the economy. Thus, remedying the social and environmental impacts

of the crisis and overcoming the structural problems of poverty and environmental destruction will require active participation in terms of policy-making, and social security systems which are in harmony with the environment and climate. One way to do this is that governments the world over must redouble their investments in advanced battery technology to reduce their dependence on petroleum for transportation fuel. They must disrupt the vicious cycle that condemns the world economy to ever slower growth until that dependence is broken. Reduction in energy cost will help in regulating the demand and supply chain in the near future. Electricity consumers may experience intentionally engineered rolling blackouts during periods of insufficient supply or unexpected power outages, regardless of the cause. Thus, these developments are startling reminders of our insatiable energy appetite. Some people may ask, "Do we have an energy crisis?" The answer is a definite yes! ■





# Keystone XL Pipeline

## The Environment vs Energy Debate

There is a furious debate raging over the Keystone XL Pipeline, the outcome of which may affect policy and pollution levels for years to come. **Arjun Wadhwa** explores this slippery issue.

Every human being eventually finds something. There is a furious debate raging over the Keystone XL Pipeline, the outcome of which may affect policy and pollution levels for years to come. Arjun Wadhwa explores this slippery issue worth fighting for. Some fight a daily battle to put food on the table for their families, while others fight for their one true love. There are many who fight just to stand up for themselves, while there are also those who fight to create a legacy of their own. And then there are those true champions — who fight for those who can't defend themselves. A few years ago it would have been easy to classify environmentalists in the last category, but with climate change making the kind of impact it has over the world in the last decade, it is safe to say that Mother Nature is fighting back! However, the reality is that we don't really want her to. She has entrusted us with the responsibility of looking after this planet — our planet — and it is our job, nay, our duty to not exploit it.







However, it is also the right of every human being to improve his own place in the world. If a farmer needs to run his tractor, he needs diesel. If a transporter needs to move his merchandise, he needs fuel. If a student needs to study in school, he needs electricity. If a woman in a village which doesn't have an electricity connection needs light, a kerosene lamp is lit. Not to mention the billion cars which take people to work every day. Progress of any form is impossible without energy, and alternatives to carbon based products have just not developed to the extent necessary to take over the ever increasing demand of our 7 billion strong population.

Hence, the Environment versus Energy War is one that neither side can win. What they can do is look to win the key battles. And one of the biggest battles in the history of our planet is being fought in North America at present, as the 1,897 km

Keystone XL Pipeline, which hopes to transport 830,000 barrels of oil per day from Hardisty, Alberta, Canada to Port Arthur, Texas on the Gulf Coast in the United States, awaits to hear its fate. The Keystone Pipeline already exists and has been operational since 2010. The Keystone XL Pipeline is proposed to traverse a shorter route across six states in the United States and go all the way down to Texas, from where the oil can be refined and also potentially exported. The pipeline is being built by a Canadian Energy company called TransCanada. Since the proposed pipeline crosses international borders, it requires a Presidential Permit through the US State Department. The President is being asked to choose a side between Big Oil and the Environment, and a decision on whether or not to go ahead with the project in the manner in which it is presently proposed is not expected before the end of 2013.

## The Battleground Issues

### Tar Sands Oil

The Keystone XL Pipeline isn't just transporting any oil — it is transporting tar sands oil. Also known as bitumen, tar sands oils are generally believed to be the least environmentally friendly as their mining and processing virtually destroys the land, whilst also releasing much more greenhouse gases than conventional oil drilling and refining. A lot more water is also used during the extraction and processing of tar sands oil. This oil is also considerably more corrosive, making it more likely to cause pipeline leaks. And to top things off, if it does spill, it is also much harder to clean than conventional oil. May Boeve, the Executive Director of 350.org, a leading environmental advocacy group, said, "The tar sands oil that would flow through Keystone XL is the dirtiest form of fuel on the planet, and burning it would have a devastating effect on our climate."

### Pipeline Route

The fact is that any pipeline built anywhere in the world bears with it some inherent risk of springing a leak at some stage of its lifespan. Should a leak be quickly contained, the damage can be minimized, and hence it is imperative that the route chosen for a pipeline also be done in such a way that the ecological risk is reduced to the maximum extent possible. One sensitive area that the pipeline is supposed to pass through is the Nebraska Sand Hills region and the Ogallala Aquifer. After having their initial proposal rejected by the Obama administration, TransCanada revised their route for the Pipeline, which was approved by the Republican Governor of Nebraska. However, the traditional red state, which is not known for its environmental orientation, has lashed out aggressively against the Government, saying that the new route

is no better and puts the water supply of the state at serious risk.

### No Acceptable Impartial Study

All stakeholders in the project — from TransCanada to state governments to the different environmental agencies lobbying against the pipeline — everyone has gone out there and had a study conducted which will measure the impact that the pipeline will have, be it environmental or economic. Almost all the studies tend to produce an outcome which is favourable to the stand of their sponsors, and as a result each one has plenty of data and experts in their corner who can justify virtually any statement they make. The net outcome of this though is a complete lack of trust amongst all stakeholders.

For example, one piece of research shows that the jobs created as a result of the pipeline will be a mere 2,000, surely not a number which merits 'destroying the environment', while the opposite end of the spectrum suggests that indirectly, the presence of this pipeline will boost the economy through the creation of 500,000 jobs.

Similarly, while the environment lobby says that tar sands emit up to 45 per cent more greenhouse gases than conventional oil, the energy industry turns around and says that blocking this project will actually increase the greenhouse gases further as the oil will just have to find an alternative means of transportation, such as rail or barge, both of which will only damage the environment further.

### Land Grab Accusations

The Keystone XL Pipeline traverses the length of America, and not everyone wants to give up their homes in the name of progress. For some, that land has been in their families for generations; for many farmers it is even the source of their livelihood, and it is quite predictable that there are accusations of people having

been bullied into giving up their lands, while others have been forced to vacate or have been evicted using Eminent Domain (the power to take private property for public use by a state). Farm owners have stated on record that TransCanada employees have told them to take the money they are offering them for the land now, because if they are forcefully evicted, they will get a lot less later. TransCanada have, of course, rubbished the allegations completely.

### Spills

When TransCanada built the Keystone Pipeline, they pitched it as the "safest pipeline ever built," based on huge technological advances. However, the company suffered a major setback when the pipeline had 12 spills in the first year alone. This number is reportedly the highest ever by a pipeline in the first year of its operation in United States history. While the presence of sensors on the pipeline and quick response teams mitigated the





impact of these spills (mostly caused by leaks), it brought the issue back to the forefront for the American people, who are still reeling from the damage caused by the July 2010 spill when an Enbridge (incidentally a competitor of TransCanada) pipeline ruptured in Michigan, spilling thousands of gallons of oil sands into the Kalamazoo River.

That clean-up activity has been going on for three years, and because of the proximity of the proposed Keystone XL Pipeline to the water supply in many states, there is serious concern about what havoc a major spill could cause. This year, a train carrying oil derailed in Minnesota, and shortly after, an ExxonMobil pipeline ruptured in Arkansas, causing further alarm and outrage in America, and giving environmentalists more fodder to strengthen their movement against the Keystone XL Pipeline.

**Pipeline Politics**

**External**

Should the pipeline be completed, the United States' dependence on oil from

Venezuela will drop significantly, as also will its use of oil from Saudi Arabia. Some experts say the need to import from these countries could even be potentially lower by 40 per cent. This has massive political and economic ramifications as far as America's foreign policy goes.

**Internal**

The Republican controlled Congress has passed legislation to speed up the work on the Keystone Pipeline a shocking seven times already, and it is fairly clear where they stand on the matter. The Republicans believe that pipeline construction will create jobs for Americans, provide tax revenues for the states, and eventually lead to reducing the price of oil in the country. The US Congress approved the Pipeline construction with a vote of 241-175, and this now puts pressure on President Obama to finally choose a side — that of the environmentalists or that of the energy sector.

**Obama-Stance**

The final decision on whether the Keystone XL Pipeline project goes through or not ultimately lies in the

Environment	vs	Energy
Less CO <sub>2</sub> emissions		Jobs
More focus on renewable sources		Rising family incomes
Prevent oil spills		Tax revenue
Preserve natural habitat		Economy boost
Stop rising global temperatures		Energy independence

hands of President Obama. While Obama has deferred his decision till the end of the year, the environmental lobby is really putting pressure on the President, reminding him of his continuous campaign promises to promote clean energy over non-renewable sources, such as fossil fuels.

President Obama finally tackled the issue of the Keystone XL Pipeline head on in his speech at Georgetown University on 25 June, stating, "Allowing the Keystone Pipeline to be built requires a finding that doing so would be in our nation's interest, and our national interest will be served only if this project does not significantly exacerbate the problem of carbon pollution."

Amazingly though both sides are claiming this as a victory, yet rather cautiously. The environmentalists believe that should Obama approve the project, he will lose all the credibility that he has tried to build over the last five years on his stance on climate change, and everything he said was simply campaign rhetoric.

The energy lobby maintains that Obama has chosen his words very carefully, and the fact that he said that the "project does not significantly exacerbate the problem of carbon pollution" means that they have the data backing them to win the race. Not only do the numbers show that one pipeline won't change all that much, it will also give the economy a boost, and Obama just cannot turn his back



on something that could help battle the recession.

The fact that President Obama hasn't yet taken a decision on the matter is evidence enough of how tough a call it is, and looking objectively at both sides, it is almost impossible to pick a winner.

**Closing Thoughts**

What started as a battle between TransCanada and a small section of environmentalists has turned into a

proxy war for climate change, resulting in thousands of people engaging in arguably the most energized civil disobedience movement for the environment that the United States has ever seen.

President Obama finds himself in the middle of it, caught between a rock and a hard place. The economic benefits in terms of jobs created (direct or indirect), money entering the economy — both into the hands of the consumers and the state, and the

energy independence for the United States are virtually impossible to refute. However, on the other hand, you face the threat of a potential disaster should an oil spill occur, not to mention all the greenhouse gases being unleashed into the atmosphere into a planet where weather anomalies are becoming almost a daily occurrence.

The Energy lobby states that by rejecting the Keystone XL Pipeline, nothing significant will be achieved. The tar sands will still produce the oil; it will still be transported to a refinery, and will still make its way to the end consumer. If anything, it will only damage the environment more by not taking the shortest, cheapest route. The Environment lobby though would see this is as a moral victory for the desire to choose alternative forms of energy over crude oil. It sees it sending a message to companies like TransCanada: just because the oil is present in Alberta, it shouldn't be exploited at the cost of the environment. It hopes to hit companies where it hurts them the most — their wallets — and by delaying such a project, it might be possible for them to win many more battles.

While logic suggests that a capitalist US economy with a democratically elected head will weigh the pros against the cons and no doubt sanction the construction of the pipeline, Obama's aforementioned speech at Georgetown University where he spoke about having the "courage to act before it's too late" and leaving "a cleaner, safer, more stable world for our children" gives environmentalists reason to hope that the heart prevails over the head.

Should Obama side with the energy lobby, we would be left with the cold words of former NASA Scientist and climate change expert Dr James Hansen to chew on: "It's essentially game over for the climate". ■





# SINK OR SWIM

Floods, storms, and heat waves caused by climate change will bring dramatic changes to our world in the coming decades. Cities will be affected the most. Policy-makers and scientists are developing strategies to help us adapt. **Astrid Diihn** reports.

The clouds that formed over Copenhagen on the afternoon of 2 July, 2011 brought the most expensive storm in Denmark's history. In just two hours, the city was hit by 16 centimetres of rain — a quarter of its average annual rainfall. Water poured into basements and underground train runnels across the city, traffic ground to a halt, and hospitals had to be evacuated. "Total damages were well above half a billion euros," says HansMartin Ftissel of the European Environment Agency, whose headquarters are in Copenhagen. Since then, the city has invested around EUR 400 million to make itself more flood-resistant, building higher steps around underground station entrances to keep out floodwater and attempting to separate rainwater drainage from residential and industrial waste water systems.

"We want to be ready for the next big storm," says Ftissel.

Copenhagen is not alone. Cities all over the world are starting to think about how to prepare for extreme weather. They call it "adapting to climate change". They are responding to forecasts by climate experts who say that severe weather, such as torrential rain, hurricanes, heat waves, and higher global temperatures will be far more common in the future. Statistics from insurance companies show that economic losses from natural disasters are already on the rise. In 2011, losses hit a new record of USD 220 billion, says reinsurance giant Munich Re. And things could get much worse. Since the beginning of the industrial era, global temperatures have increased by 0.8 degrees Celsius (DC). A new study by the World Bank describes scenarios with



“Businesses have not been doing much to prepare for the challenges that lie ahead.”

Andreas Vetter, Federal Environment Agency

increases of 4 to 5 DC by 2100. “Despite all of our climate negotiations, global carbon dioxide emissions have risen by more than 40 per cent since Kyoto. The climate system has a lag, so we should expect higher temperatures in the medium term,” says Olivia Serdeczny of the Potsdam Institute for Climate Impact Research, which conducted the study.

The scenarios show polar ice melt leading to a rise in sea levels of around one metre as a middle-of-the road prediction. As Serdeczny explains, “These are only hypothetical scenarios. However, the potential consequences are terrifying.” Cities face the greatest risk. Urban centres are much more vulnerable to climatic disturbances than less densely populated areas. They are hubs of energy, water, transport and data infrastructure for entire regions. Businesses and banks have their

headquarters there. “Cities provide the lion’s share of a country’s economic output,” says Ftissel. “If London is flooded or New York shuts down for a hurricane, this has a huge impact on the prosperity of the entire country.” Cities are hotspots of vulnerability, says Ftissel, especially since they are often located by the sea or on large rivers, where flooding is more common.

The World Bank study says that fast-growing megacities around the equator, most of which are in developing countries in Africa, Asia and Latin America, will be hit especially hard by climate change (see interview on page 54). China seems to be the only country in Asia that is making serious efforts to deal with climate change. Over the next ten years, the Chinese government is planning to put around EUR 500 billion into improving facilities such as the country’s water

infrastructure in the hope of protecting large cities in the increasingly drought-plagued eastern provinces against water shortages. India may be putting up a 4,400-km long barbed-wire fence along its border with Bangladesh to keep out people expected to flee that flood-prone country, but it does not have a broad strategy for adapting to impending changes in the climate. The bulwark is scheduled for completion in 2014.

**Funding for Climate-Change Research**

Meanwhile, in industrialized countries in the West, the subject has been receiving more and more attention. In 2009, the European Commission prepared a white paper on the topic which it will shortly publish as a European strategy for adapting to

climate change. Germany adopted a similar plan back in 2008. Since then, the German government has been backing related initiatives such as the Klimzug Project, which works in seven pilot regions to help local communities deal more effectively with climate change. The five-year project will receive more than EUR 80 million in funding from the Federal Ministry of Education and Research. The first thing that needs to be done to equip urban spaces effectively is to determine exactly how they will be affected by climate change. Current climate models tend “to cover too large an area for the job.” Most of them can only make blanket statements for zones of about 50 km across. That’s fine for agriculture, but not for analyses that depend on micro climates in individual neighbourhoods and streets,” says Ftissel, who is responsible for these kinds of modelling questions at the EEA.

Today’s computer models are at their most reliable as regards statements about how temperatures will change in specific parts of a city. Cities hold heat, so their centres are often several degrees warmer than their outlying areas. As climate change progresses, the difference is likely to grow. The World Bank study predicts that the average mid-summer temperature in some large Mediterranean cities could rise by up to 9 degree Celcius. Central and northern Europe will also see longer periods of hot weather. To get an idea of what the future might have in store, one need only think back to the four-month heat wave in the summer of 2003 that claimed the lives of more than 3,000 people in Paris alone. “That was a clear wake-up call for Europe’s municipal authorities,” says Ftissel. Stuttgart is one of the cities leading the fight against heat accumulation. The city is situated in a valley surrounded by low mountains, so smog and heat get trapped in the basin. As early as

the 1970s, the authorities put together a detailed climate map of the city and built ventilation lanes through the sea of buildings to allow cooler air from the surrounding mountains to flow into the valley. Inspectors still make sure that no new construction projects block these corridors today.

Large-scale urban planning is not the only way to counteract urban overheating — small changes can help too. “Some cities in California are experimenting with white asphalt, which is better at reflecting the sun’s heat,” Ftissel explains. New kinds of architecture can also make a difference. “The most important things are good insulation and natural ventilation systems that block solar radiation without the need for power-hungry air conditioning systems,” says Bernhard Muller, scientific coordinator for Regklam, the regional climate adaptation programme in Dresden. He points to the building where he works as an example. The Leibniz Institute of Ecological Urban and Regional Development, which Muller heads, was recently renovated to withstand future heat waves and use 25 per cent less energy. It achieved this impressive goal by installing new insulation on the facade, a photovoltaic system on the roof and automatic sun blinds on the building’s south side. Structural engineers from TU Freiberg contributed to the Regklam programme by designing an underfloor ventilation system for large rooms that uses crushed stone to keep the space at a comfortable temperature. They are currently testing their design under a new factory floor using a foundation which is made of roughly crushed rock and has air passageways. The system works like a cold storage tank, with the cold rock drawing in warm daytime air from outside and cooling it by five to ten degrees before it enters the interior. At night, cool outdoor air flows through the crushed rock foundation,

**Megacities are Gaining Ground**

Urbanization is a global trend. There are now 30 megacities with over ten million inhabitants each, 22 of which are in developing or newly industrialised countries. According to the UN, the urban population in developing countries will increase by around 180,000 people per day until 2015. Cities consume vast amount of energy, accounting for some two-thirds of the global consumption of electricity and heat.

Transport makes up 30 per cent of the energy demand, with electricity and heating accounting for 30 and 40 per cent respectively. As a result, says the latest UN-HABITAT report on cities and climate change, conurbations currently produce up to 70 per cent of global carbon emissions.

The UN report says that the urban population’s average annual income per capita has increased by around 150 per cent worldwide in the past 50 years. Productivity is also increasing in conurbations. New York produces ten percent of the US’ entire gross domestic product. Sao Paulo, Brazil’s financial centre, generates 25 per cent of the country’s gross domestic product, while the 53 largest urban regions in China, each of which have over a million residents, produce just under two-thirds of all of the goods and services [not including agricultural products] in the country.





refreshing the cold reservoir. The engineers estimate that the new foundation will save the factory about 10,000 litres of heating oil each year.

**Trees Block Heat**

Planting trees that provide shade to buildings, squares and paths is an equally effective and much simpler way to block the sun's heat. The only problem is that the types of trees that have traditionally served this purpose, such as chestnut and plane trees, will probably not be able to withstand the challenges brought by climate change. "We need trees that can survive hotter, drier summers and cold winters too," says Monika Meiser of Inka BB, the Innovation Network for Climate Change in Brandenburg and Berlin, part of the Klimzug programme. Horticulture specialists from Berlin's Humboldt-Universität and Inka BB are experimenting with new varieties of trees that will hold up better under these extreme conditions. They are mainly looking at trees such as Japanese zelkova and Osage orange trees, which come from parts of the world that already have the kind of conditions being forecast for Germany. A large-scale research campaign in Bavaria called Stadtgrün 21 is trying similar experiments. "Climate change could make our cities look much more exotic," says Meiser.

And greener. Urban planners all over the world are turning to vegetation for

solutions. Stuttgart, for example, has stopped putting gravel along its tram tracks, opting instead for grass. Grass is being used elsewhere too, such as on rooftops and the edges of streets, because it absorbs heat and sucks up rainwater. Instead of running into basements like it did in Copenhagen, the water seeps down into the soil. Paul Dostal of the German Aerospace Center calls this a new kind of urban soil management. An environmental scientist, he coordinates some of the Klimzug projects for Germany's research ministry. For him, better soil management also involves removing the non-permeable rubble often found under green spaces. The city of Dortmund will soon begin removing concrete slabs from under one of its parks and installing a water drainage system. The work will cost around EUR 100,000 per hectare, but draining flooded basements costs more in the long run, says Dostal. Architects in Hamburg installed rainwater drainage for an entire housing development on the grounds of the old Farmsen racetrack. The difference is that this system is above ground and allows water to flow down channels into several ponds in a small park in the middle of the complex. Wolfgang Dickhaut, a professor of environmentally friendly architecture and urban planning at Hamburg University, calls it a pioneering design. "These canals are

much easier to widen than the pipes that are normally put in the ground for drainage." This means that they can be adapted quickly to new information on the effects of climate change, he adds. If climatic changes turn out to be less severe than expected, the grassy areas along the canals can be used as places for children to play and adults to relax.

People's quality of life will be better either way, he says. Another example of these no-regret fixes, as climate researchers like to call them, is the floating house. In Amsterdam's new residential archipelago IJburg, all of the buildings can float. Their foundations are made of unsinkable concrete pods that are chained to piles so they can move up when water levels rise. The new design is one of the ways Holland is responding to the growing threat of floods. One-third of the country already lies below sea level, and by the end of the century the sea level is expected to rise by another 20 to 150 centimetres. An ingenious system of dykes has protected the country from North Sea waves in the past. But maintaining these dams is expensive. Floating houses could help people live with a deluge. "Amsterdam's residents are learning by doing when it comes to dealing with the dangers of climate change," Dickhaut says.

The 2003 heat wave killed thousands in Paris alone. Many city authorities are following Paris's lead and setting up early warning systems to protect their citizens. The Parisian government has created action plans that tell the elderly and sick how to call for help in an emergency. In Berlin, pulmonologists from the Charité teaching hospital are working on a remote diagnostic procedure for the Inka BB project to help people with chronic respiratory diseases who are particularly affected by hot weather and smog. A mobile measuring device enables patients to regularly check their condition and send the results to the hospital.



In 'turn, this helps doctors to detect weather-related health issues early on. "Patients need to be made aware of the risks that come with climate change," says Meiser. Many of them do not know anything about it, she adds. Experts agree that not enough people outside of political and scientific circles know about the need to adapt to the climate. Andreas Vetter of Kompass, the Federal Environment Agency's centre of excellence for climate change and adaptation, says that his organization is trying to get the word out to all parts of society. The centre publishes information brochures, funds research projects, and provides communities and industry with scientific advice on what adaptation strategies work best. The Federal Environment Agency's team hopes to share its ideas with legislators and standards boards too. The goal is to bring regulations in line with future environmental challenges. The agency wants the insulation and roofing materials of the future to be designed to withstand heavy hail, storms and torrential downpours. It is also calling for road surfaces and



People living in Leipzig, Chemnitz and Dresden can now use this ZURS public web database to find out how likely it is that their house will be affected by a flood. The GDV is aiming to expand the adas to include all of Germany in the coming years.

Munich Re is involved in even bigger projects. Two years ago it introduced micro insurance for countries in the Caribbean facing a greater risk of hurricanes as a result of climate change.

The Federal Environment Ministry helped to fund the scheme.

Munich Re spokesman Michael Able says the policies cost just a few dollars a year, but they are enough to insure very small businesses against the increasing number of weather disasters, especially

Experts such as Schwarze warn that we should not put adaptation strategies ahead of climate protection. They fear that some countries might only think of maintaining their own standard of living — there is a danger of them losing sight of the big picture. After all, reducing carbon emissions is still absolutely essential. Granted, the insurance industry does expect adaptation measures to be within our means for the time being, at least for a wealthy country like Germany. A recent position paper on adaptation strategies in climate policy by Acatech, Germany's National Academy of Science and Engineering, also comes to this conclusion. However, it says that this will only hold true if global warming does not exceed 2 degree Celsius. "For anything significantly higher, we can no longer make any reliable predictions," says Reinhard Hüttel, President of Acatech and Chairman of the board at the German Research Centre for Geosciences in Potsdam. He points out that the situation could get completely out of control. Cleverly combined with climate protection, adaptation could thus become a new driving force in technology. At this point, no one is sure to what extent all this will be necessary. One thing is for sure though, says Hüttel: "There is no way around adaptation. The history of evolution makes that very clear." Adapting our cities to the future is just another part of that. ■

**"The climate system has a lag, so we should expect higher temperatures in the medium term."**

*Olivia Serdeczny, Potsdam Institute for Climate Impact Research*

rails that do not melt or crack when temperatures rise. As Vetter explains, businesses are not required to do any of this yet. They have not been doing much to prepare for the challenges that lie ahead, he says.

The insurance industry has been the only exception to this rule. Its success has always depended on accurately assessing risks to minimize its losses. Recently, the German Insurance Association (GDV) got together with local authorities and scientific institutions to create a detailed flood atlas for Saxony.

in cities. Still, insurance alone will not be enough to protect high-risk, low-income megacities along the equator from future catastrophes. The European Environment Agency estimates that the international community would have to give developing countries around USD 100 billion every year to help them stay in step with climate change. "It would be useful to have a solidarity fund of some sort that would transfer both money and technological expertise from rich nations to poorer countries," says Reimund Schwarze of the Helmholtz Centre for Environmental Research - UFZ in Leipzig.

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# THE STRUGGLE TO SELL SOLAR

To improve the integration of photovoltaics into the grid, solar operators are supposed to sell more of their electricity on the free market. But the German government's incentives are inadequate and overly complex. **Sascha Rentzing** reports.

The amendment to the Renewable Energy Sources Act, which entered into force on 1 January 2012 introduced the market premium model. The idea is that this premium will improve the integration of green power into the electricity market. Solar plant operators jumped at the new opportunity: According to the four German transmission system operators, solar plants with a total capacity of almost 2.5 gigawatts (GW) switched from the Act's fixed feed-in tariff to direct marketing. This means that electricity from around seven per cent of German solar power plants is now being sold on the electricity exchange or to direct customers.

"The law aligns electricity supply and demand; it reduces the cost of the Renewable Energy Sources Act surcharge and hence the burden on consumers," says Federal Environment Minister Peter Altmaier. To encourage producers of green energy to make the switch, the government is offering generous subsidies. If the price on the electricity exchange is lower than the tariff fixed by the Act, the producer is paid the difference from the Act's



pot—this is the "market premium": If the price is higher, operators keep the profit. They also receive a management premium—currently EUR 0.0065 per kilowatt-hour (kWh) of solar electricity. This enables plant owners to pay a trader to sell their energy for them. One of the trader's tasks is to ensure that the promised electricity can actually be supplied. This involves buying solar forecasts from specialist companies and employing analysts who constantly monitor the output of the solar plants managed by the trader.

Despite the work involved, direct marketing is worthwhile. "For solar plants or portfolios with a capacity of one megawatt (MW) or more, we guarantee a better return than the present feed-in tariff," says Tim Meyer,

managing director of Hamburg-based Grünstromwerk. Various public utility companies, financial investors, and individual plant operators have already entrusted their plants to the company.

However, operators are having to grasp the fact that the money will not come in so easily in the future, as it is unlikely that the market premium model will remain in place for long. Industry associations and the opposition in Berlin are calling loudly for it to be overhauled on the grounds that it does not work in its present form.

The idea is that the output of green power plants should be more closely linked to actual demand. For example, if operators were to feed in their production at times when demand is high, they could obtain higher prices







on the electricity exchange and the cost of the Renewable Energy Sources Act surcharge would fall. But technical limitations mean that very few plants can adjust their output to market needs. "Without storage facilities, operators can only respond to market prices and strategic orders on the electricity exchange by switching off production. But the market premium model does not provide enough incentives for operators to create additional storage," explains Daniel Kluge, spokesperson for the German Renewable Energy Federation (BEE).

As a result, the power plant owners go on producing electricity and rake in the full premium for doing virtually nothing. These windfalls are an additional burden on the already stretched Renewable Energy Sources Act budget. The BEE estimates that the additional cost of the management premium amounted to EUR 400 million in 2012; this year it expects the figure to rise to as much as EUR 430 million.

Even if the market premium system is not changed, the new market integration model — the second instrument adopted by the German government in the amendment to the Renewable Energy Sources Act — represents another hurdle for many operators. Under this new system, which is designed to encourage

initiative among solar operators, large rooftop systems with an output of between 10 kW and 1 MW that have been operating since 1 April, 2012 will receive payment for only 90 per cent of the electricity they produce from 1 January 2014. The remaining ten per cent will receive the average electricity exchange rate, which is currently around EUR 0.045 per kWh — at least EUR 0.10 less than the Act's current tariff for plants in this category. If this is unacceptable, producers must either use the surplus electricity themselves or sell it elsewhere.

Using the electricity themselves is the simpler solution. Large solar plants currently generate electricity for less than EUR 0.15 per kWh — but according to the German Association of Energy and Water Industries (BDEW), electricity from the grid costs private end customers an average of EUR 0.25. Using your own electricity, therefore, saves you EUR 0.10 per kWh at current prices, and this figure is likely to rise. All that you need to do is install a new meter that records not only the electricity used, but also the amount fed into the grid. A second meter measures the electricity generated by your solar panels.

Unfortunately, though, there is a hitch: Most large-scale systems are installed on other people's roofs,

making it impossible for producers to use the electricity themselves. Operators set up solar plants on commercial or public buildings, such as schools, while housing associations install them on multi-occupancy buildings for the benefit of their tenants. Since the operator and the user are not identical in legal terms, the plant owners' only option is to sell the 10 per cent of electricity elsewhere, but this involves a number of uncertainties and additional costs. "When electricity is sold to a third party, various price components usually have to be added," explains Margarete von Oppen, a lawyer with the Berlin-based firm Geiser & von Oppen.

The charges and levies that apply depend on the specific marketing model chosen by the plant owner (see chart). When electricity is sold, the Renewable Energy Sources Act surcharge must always be paid to the transmission system operator. If the public grid is used, the distribution network operator levies a grid charge for the use of its transmission lines. This includes the combined heat and power surcharge that is levied to refinance the funding of combined heat and power plants and the concession fee paid by the energy supplier to the municipalities in the areas through which the transmission lines run. Finally, an electricity tax must be paid when electricity is taken from the grid. "An operator must add these charges, which amount to up to EUR 0.10 in total, to the electricity production costs of its photovoltaic system. It is only worth selling solar electricity if the costs are less than the electricity price," explains von Oppen. If all the components apply, it is usually uneconomical to sell the electricity.

From a legal point of view, a consortium of operators that wants to sell its 10 per cent of solar electricity to a school in the neighbouring town would supply the energy via the public



grid on a non-location-linked basis and would, therefore, have to pay all the surcharges and levies. If the consortium produced the solar electricity for EUR 0.15, it would have to sell it for at least EUR 0.25 to cover its costs. If a margin for the operator is then also factored in, the total costs rapidly exceed the price of grid electricity and the deal with the school is likely to fall through.

Operators could, however, save some of the charges through skillful marketing. "If the electricity is used in a location near the plant and not channelled through a grid, many of the components of the electricity price no longer apply," explains von Oppen. For example, this would be the case if a landlord sold the electricity from his rooftop system directly to his tenants in the same building: the landlord would only pay the Renewable Energy Sources Act surcharge (reduced by EUR 0.02 under the so-called solar green energy privilege) to the transmission system operator. This privilege benefits energy suppliers who only provide solar electricity. In this case, the landlord and tenants can happily do a deal: Given production costs of EUR 0.15 and a reduced surcharge of EUR 0.033, the provider will make a profit at any price over EUR 0.183. A landlord could, thus, offer his tenants a lower rate than the current domestic electricity price.

Those who do not want to sell their electricity themselves can use the services of direct marketers or solar plant providers. "We are working on all-

in packages for investors that include everything from system planning to electricity marketing," says Karl Kuhlmann, CEO of the Freiburg-based solar energy company SAG Solarstrom. The company has the advantage that its subsidiary Meteocontrol is a prominent provider of yield forecasts. Good forecasts are crucial to optimizing own use and successful trading on the electricity exchange.

The project developer Solenergy in Niebiill is already a step ahead of SAG Solarstrom: last year it installed a 1-MW solar power plant on six newly built barn roofs in Uckerland, Brandenburg; the electricity produced by this plant is already being sold in accordance with the market integration model. "As an investor in the system, we estimate that we sell between ten and 15 per cent of the electricity to two farms, each of which has three barns," explains Philip Zidowitz, managing director of Solenergy. The two electricity purchase

agreements stipulate that Solenergy will supply the electricity for 20 years at a guaranteed fixed price of EUR 0.1586 per kWh. This is exactly the same as the Renewable Energy Sources Act feed-in tariff that the company receives for the system, which was installed in August 2012.

"This business model is a classic win-win situation," Zidowitz says. His contract partners used to pay EUR 0.17 for their electricity, but will pay over EUR 0.01 per kWh less than this for quite some time to come. In turn, Solenergy benefits from a guaranteed return through the fixed electricity purchase agreements and payment under the Renewable Energy Sources Act for the rest of the electricity. However, Zidowitz did not get everything right: for the electricity it supplies, his company has to pay the reduced Renewable Energy Sources Act surcharge of EUR 0.033 to the transmission system operator 50Hertz. This should have been added to the electricity price of EUR 0.1586 paid by the farmers, but because Zidowitz failed to include it he actually earns only EUR 0.1286 per kWh. Germany's marketing rules really do need to be simplified—soon. ■

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# WARREN BUFFET

## Stepping Up the Solar Initiative

"Invest", says billionaire-philanthropist Warren Buffet. **Viraj Desai** finds that the solar energy sector is where all the action is.







A good investment is as good as the return it generates. This adage may hold perfectly true for one of the world's richest men who is venerated for his insightful investments. Warren Buffet, also known as the Oracle of Omaha, continues to make investments in the niche sector of renewable energy, raising many questions in the minds of people while at the same time generating immense confidence in the sector, which has for long been marred by various factors across the world. For a man known to send an annual letter to shareholders with the simple objective of ensuring returns to investors, it is safe to assume that he must have seen good returns in many an investment touted to be risky.

Billionaire US investor Warren Buffett's bold move to invest US\$ 2.5 billion to acquire what would be the largest photovoltaic solar power

plant in the world is being keenly tracked and looked at as a potential deal which may decide the course of the untapped power source in future. MidAmerican Energy Holdings, a subsidiary of Buffett's Berkshire Hathaway investment company, has got into a deal with SunPower for acquiring and building two projects in California's Antelope Valley.

The company SunPower has a market value of US\$ 732 million. The two projects acquired by MidAmerican would have a combined capacity of 579 megawatts (MW), leading to the creation of the largest solar photovoltaic power development project in the world. In addition to this, it is expected to generate 650 construction jobs according to SunPower. California is the biggest solar market in the US. In total, the Berkshire Hathaway subsidiary has

more than 1,830 MW of assets, which includes wind power, geothermal, and hydro projects.

Buffett's foray into renewables through the subsidiary MidAmerican Solar has been of tremendous interest as it has acquired a few of the largest solar projects in the world. So what lies beneath the man's aggressive moves, and does this augur a likely transformation that the sector may witness in the future?

### A Peek into the Past

MidAmerican Solar entered the niche market in 2012 with the backing of its parent company, Berkshire Hathaway's MidAmerican Energy Holdings Company, having annual revenues to the tune of US\$ 11.2 billion and assets worth US\$ 48 billion. With a natural gas pipeline and electric utilities in the UK and the US, the enterprise has taken

a serious plunge into the renewable sector through interests in diverse segments, such as wind, geothermal, solar, and hydro power.

The company's financial muscle has helped it quickly transform into an important player in the solar market in a brief span of time. Buffett's company started a series of acquisitions by first acquiring the 550 MW Topaz Solar Farms in San Luis Obispo County, California from First Solar in January 2012. The project is expected to be completed by 2015 for which it has signed a power purchase agreement with Pacific Gas and Electric. Any other company entering a sector which is at such a nascent stage would not have thought of the acquisition of such a large-scale project. Thus, this move is likely to leave a lasting impression on companies around the world who still doubt the viability of solar projects. The company moved to acquire a 49 per cent stake in a 290 MW Agua

Caliente project in Yuma County, Arizona. The project, being built by First Solar at a whopping US\$ 1.8 billion, is expected to be complete by 2014.

If one thought that these two projects were enough for the company's appetite, the biggest one was yet to come. The 579 MW Antelope Valley Solar Project was bought from SunPower in January 2013 and would power Southern California.

Hence, the company has a stake or owns projects totalling to a capacity of over 1 gigawatt (GW). Such a gargantuan foray into renewables in two years should boost the confidence of other developers across the world as Warren Buffett is known for his superior investment prowess. Despite all the negative hoopla surrounding alternative forms of energy, the sector and its companies can take a cue from the veteran billionaire-philanthropist about the sanguinity of the sector. However, some people opine that

these steps have been taken to push the Green agenda of President Obama, and also to mitigate the tarnished image of the sector in the country, a fallout of the bankruptcy of Solydra, the California thin-film solar manufacturer which received a US\$ 535 million US Energy Department loan guarantee. But Buffett never mixes investment and politics and his doctrine — "Rule No. 1: Never lose money. Rule No. 2: Never forget Rule No. 1" — is certainly worth a mention here! Even though the billionaire is an outspoken supporter of the present administration, experts are of the view that Berkshire Hathaway will not move on any part without financial analytics.

In response to questions, whether on the first solar acquisition or with respect to MidAmerican Solar, President Paul Caudill has said it all. He said that even though the company is committed to reducing the carbon footprint, the importance of business





fundamentals of risk, capital, and market dynamics cannot and must not be ignored. Further, Caudill felt that wind and solar energy projects are solid as long-term investments.

### Is Pouring Money into Solar Power a Good Risk?

Long-term contracts with utilities and plummeting of solar prices make solar an attractive proposition for MidAmerican to get into this segment. Even though the gas prices are currently low, they will eventually rise. The rise in electricity prices and fall in solar is the simple logic behind the company's early move, which would clearly be advantageous to it in the long run.

Besides this, the relative comfort of using various photovoltaic technologies is another factor helping the go-ahead. Even though the firm's first three investments were in big projects, it is eyeing smaller projects in the 20–40 MW range for the future.

The company's perfect timing in buying projects is also worth noting, just as any good investment is. The balance of risk and cost makes it a safer bet. The guarantee of Power Purchase Agreements as well as discounted prices make it a sweet spot to venture. With guarantees including access to transmission, generation interconnection agreements, and permits, the projects were quite far along in terms of their development. For every company whether new or

experienced, the selection of projects having the right mix of agreements in place demonstrates how a strategic and planned approach can lead you to projects fetching assured and healthy returns in the long term. Besides this, choosing companies having a proven track record was a vital consideration behind choosing the three projects. Tying up with NRG energy, one of the largest solar developers in the US, and acquiring projects from First Solar which has to its merit construction of some of the best projects, were all worthwhile moves.

It may seem easy spending billions of dollars on projects when you are sitting on a pile of cash, but Buffett's decisions actually make companies sit up and take notice. The move by MidAmerican

may prove to be a big motivator for large institutional investors to look more closely at solar projects, both in the US and internationally. Quoting Buffett again when he famously proclaimed, "Stay away from investing when others are greedy and be greedy when other are scared" seems to be apt here. The effects of these investments may lead to companies and investors following suit in a sector which has a harsh time convincing bankers about the kind of returns it can generate.

A good investor can learn to offset a reasonable amount of tax through investments in solar energy. There is no doubt that the company would have anticipated sustainable returns for these projects only after which it would have moved ahead.

### Possible Positive Effects of the Deals

The mere reputation of Buffett's investing philosophy in undervalued assets may prove to be a game changer in this sector, hence pushing for bigger investments and helping in overall reduction of carbon footprint. The combined benefit of investment in the environment along with economic sagacity is what would determine renewable policies in future.

Another important thing which would motivate developers is that the company targets investments which would fetch returns over the long term. Hence, this offers a positive outlook to the future of solar energy. The effect of MidAmerican's deals

resulted in soaring of other solar firm stocks, signalling increased confidence amongst investors.

On one hand, where margins of various manufacturers have been hit due to fierce competition, Buffett's renewable company's move to go through the inorganic route is a sensible one in the wake of increasingly cheaper products flooding the market. This is a bigger boon for developers as the price of solar panels continues to plummet. To top it all, stable incentive regimes when the project is up and ready adds to its reliability.

Hence, the acquisition of solar plants is a well thought out one, and companies in this space, or those looking to get into it, must study the due diligence that needs to be done





while setting up or owning any plant. If any of Buffett's big projects are set up and deliver as anticipated over the next two years, it would provide a massive thrust to solar power in the US as well as to the sector worldwide. It would open up to various other big players, who have the financial muscle but are unsure of the returns the sector can give over the long term, the possibilities of the solar sector. Besides this, projects would start winning faster approval of banks for funds, ensuring fewer delays in the commencement of projects.

Not only big projects, the banks would also be able to place faith in even small investors keen to foray into the solar market. Hence, small home-based or community-based projects would help in allowing many homes

to contribute towards supplying energy. Risk assessment is done in big projects to see creditworthiness of the power buyer, quality of equipment, site design, and insurance adequacy.

With energy representing about 1.8 per cent of Berkshire's 38-stock portfolio, Buffett clearly identifies this as a sector which is likely to witness stupendous growth in the near future due to increasing energy demands and depletion of fossil fuels.

### Concluding Thoughts


The demand for energy will go up in the future and the exhaustion of fossil fuels indicates that costs for having access to energy would also be high. Hence, it is high time that development of alternative energy is done in earnest.

The entry of Warren Buffett into the sector demanding urgent attention is an indicator to corporates, institutional investors, and corporate honchos that the time has come to help the world stave off a massive energy crisis in future.


The intricacies of Buffett's mastermind regarding investment may not be easy to decipher but a close look at all the moves demonstrates a single most important trait — the ability to identify a trend or a potential opportunity much before others. Whether or not the step leads to sustainable and good returns remains to be seen, but the very fact that one of the world's richest men is willing to put a large sum of money into it is a great reason for many more to explore it. ■



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# Societies have gone completely out of control in terms of consumption and wastage

**Venkatesh Valluri** is the Chairman and President of Ingersoll Rand, India, and a member of Ingersoll Rand's Global Executive Leadership team. Mr Valluri serves on the board of United Way India and represents the company at various government and industry-led committees in the area of Technology, Food Security, Cold Chain, Energy Efficiency, Security Technologies, and CSR initiatives. He also serves as a member of the National Executive Board of AMCHAM, and chairs the National Committee on Technology of the Confederation of Indian Industry (CII). *Energy Future's Shilpa Mohan* reports his views on sustainable development.



## Could you please describe the role you envision for the enterprises and the private sector for sustainable development?

Let me form a broader perspective on the possibility of energy utilization in the future for private enterprise. The rhetoric today is to ask why we resign coal-based plants, why we resign energy-generating infrastructure which is using either fossil fuels or its inputs which degrade the environment. So there are two aspects, and we need to be a little practical about it. If you look down the last 20–30 years, you never had technology that could basically deliver clean energy, and nobody had thought of doing away with using the natural resources which

degrade the environment, such as coal, gas, and other fossil fuels. It has been only 10–15 years since we have begun to understand the impact of using fossil fuels or such raw materials that actually come from the earth's surface; when we actually start using them, they start getting depleted or affect the ozone layer and cause various other negative impacts. So we should be more careful while using them as we now know how their use has been affecting the environment. Society never realizes what harm its technology can cause to the environment, since it has been figured out already that it will help in the advancement of society. So what happened in the past it was due to our ignorance but now, as we know,

we are more aligned to the fact that we have to create clean energy for sustainable development. We need to have technology interventions, and when I talk about technology interventions, I mean solar, wind, or any other similar form of energy. We need to have such interventions to generate energy for society. One thing is for sure: we will need energy, so what are the options available today? Whether it's an emerging country like India or any other developed economy of the world which uses a lot of energy, we need to drive technology to deliver. There is a lot of work going on in Sudan with wind, which I think is one of the best forms of renewable energy. To use natural resources, even if we do not

deplete anything, we are still a long way off from saying we can actually produce energy sustainably. You have the largest solar power plant in Gujarat but we need a lot of space for that, you have windmills running but we need the right kind of angles for that and the right kind of space where wind is being generated. But how can you spread the word of energy efficiency and sustainability across? I think for us as a country, I would recommend a model using a distributed energy grid, i.e., we should have a central energy generating store (combination of wind and solar) for 100,000 people living in a particular area. We need to invest in solar, wind, and other sources of

renewable energy. Efficient utilization of energy is also very important; how residential dwellings can be converted into energy hubs should be looked into. So we should focus on two aspects: how to produce energy sustainably — and I do see solar as the major source of sustainable energy — and how to use it in a more sustainable way and reduce utilization.

## How much do you think the economic recession has affected the sustainable development and clean energy movement?

Economics is one piece, and then social good is the other piece, and I think both are inter-connected. If the social good



or the public good does not take place, you have social unrest. When you have social unrest, it impacts economies, so the developed world's economies add a point where I think the consumption levels come down. I look at this more positively because I think societies have gone completely out of control in terms of consumption and wastage. You often tend to consume more than you need. When you get into that inflation point when consumption is more than what you need, then it will be called wastage. I think the developed world has gone into a mode of saying, 'I want to consume more even though I don't need it. I'll make more wastage.' What happens is, we reach a point when consumption makes no sense, you can't have ten pizzas a day or you can't be having junk food all the time, there is no point consuming so much. This is why you see economies cooling down, and when economies cool down, production comes down. The emerging economies built a model which said that if the developing economies are consuming more, we need to export more. So to your question, the developed world is driving the economy negatively because it is unable to absorb. Is it impacting the developing world?







The answer is yes! But is it impacting it in a manner that is fast enough to re-engineer its energy consumption models to serve societies which cannot bear these price points? I think that is where the challenge is coming from. So that is really the biggest point of saying how do I build products and solutions which are more relevant to a society which does not have the same pricing power as the developed world, but has got a different price point and a different value. And now the lesson we all need to learn is that you don't build products and solutions where you drive the society to consume more than it needs, which is a mistake in the developed world. The living standards may come up but the consumption should not be beyond a limit.

**There are many people who believe that green growth and**

**resource-efficient growth is not possible in emerging economies like India because of the scale of development that is needed in the country. Do you think we can merge goals such as green growth and resource efficiency in such developing countries?**

You know, the younger generation today is not going to sit pretty and say, 'Because there are environmental concerns I am not going to change my living standards.' They are going to be an impatient generation. They will say, 'Even I want to live well.' In emerging economies like India, people are young, energetic, physically capable, mentally agile, and will say, 'Listen, I want to improve my living standards. You can't push them down to poverty and tell me how to live because there is an environmental concern.' But on the other hand, if you

are not going to improve your living standards with more environment-friendly technologies, you have the danger of ruining the environmental ecosystem. For example, right now if you look at China, the people are unable to breathe, the air over there has some 100 times more than the tolerable levels of pollution, people are now putting on masks and moving around. So you have a danger of saying that you have a system which says, 'I want to live out of poverty, and I want to live well.' You have other dangers of saying that if I undertook development in the traditional sense, then I am going to get into a situation like China where I am going to have pollution and health issues. But you can't say, 'I can do one in the absence of the other.' So there should be development, but responsible development. ■

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# THE THEORY OF ABIOGENIC PETROLEUM ORIGIN

It is derided by some as an effort from the pro-oil lobby to continue to live in denial in the face of rapidly depleting global fossil fuel reserves and the impending doom of Peak Oil, whereas it is hailed by its proponents as a far more rational explanation for the formation of oil, coal, and other fossil fuels by admittedly a maverick scientist, someone who was once disparaged by the scientific community before his findings came to be accepted as fact. The abiogenic theory of the origin of oil is one that finds little common ground between its most ardent supporters and critics. The traditional explanation for the presence of long-chain hydrocarbons stored in the Earth in the form of oil, coal, and natural gas is that they are

the remains of organic material, i.e., prehistoric plant and animal life, that was fossilized millions of years ago in anoxic conditions. Most of these were formed at the bottom of the sea and lakebeds, usually in the Cretaceous Period, which was the last era of the dinosaurs, sometime between 140 to 65 million years ago.

This period in Earth's history saw extremely high levels of greenhouse gas emissions due to very intense volcanic activity. During the Cretaceous Period, the amount of atmospheric carbon dioxide was in the range of 1,700 parts per million (ppm); for comparison, the mean atmospheric carbon dioxide (CO<sub>2</sub>) content in pre-industrial times was 280 ppm, and in the last 200 years of the industrial revolution, this

figure has risen to almost 400 ppm. Unlike today though, the rise of carbon dioxide in the atmosphere during the Cretaceous period was a gradual process that occurred over a span of millions of years. One of the biggest consequences of such high levels of carbon dioxide in the atmosphere was warming — the earth's mean surface temperature during the Cretaceous was 18 °C, over four degrees higher than today. Due to the unusually high amounts of CO<sub>2</sub> in the atmosphere and the associated high surface temperature, the natural process of oxygen exchange that occurs due to the difference in temperatures between the ocean surface and its depths (a process known as 'upwelling') stopped in the Earth's water bodies,

and the bottom of these ancient seas and oceans ended up bereft of oxygen (anoxic). The high levels of CO<sub>2</sub> in the atmosphere also led to a surge in marine species, such as phytoplankton, that absorb carbon from the atmosphere and into the ocean. These and other marine plants and animals, when they died and settled at the bottom of the lakes and seas, could not decompose quickly as the deep seas had too little oxygen and there were too many dead aquatic plants and animals to decompose. As the millennia passed, heat and pressure, both initially from the oceans lying above them and, as plate tectonics shifted these seabeds around, from the land above them caused a chemical process known as catagenesis. This eventually converted these dead, undecomposed marine fossils into coal and oil, which is why they are known as fossil fuels.

The abiogenic theory, however, dismisses this and proffers an alternative solution. Its earliest proponents were nineteenth century scientists, such as Alexander von Humboldt and Dmitri Mendeleev. In modern times, it's fiercest advocate has been eccentric Austrian-British (and then, later, American) scientist Thomas Gold. Dr Gold's scientific career is chequered with great discoveries that were initially rejected by the mainstream scientific community. His theory to explain strange and distant radio signals led to the discovery of 'pulsars', the remnants of massive stars that had now collapsed into small, dense objects that emitted strong electromagnetic radiation at regular intervals. This theory was dismissed at first in 1952 as he had stated that the source of these signals existed outside our Milky Way galaxy. He also mentored Carl Sagan and Frank Drake, who were to become luminaries in the field of astrophysics. At the same time, he is also known for holding fast to theories well past their "sell by"

date, as evidenced from his conviction that the antiquated 'Steady State Theory' for explaining the origin of the universe was accurate despite mounting evidence in the favour of the 'Big Bang Theory'.

The abiogenic theory of the origin of oil states that oil, coal, and other hydrocarbon-based fuels are formed deep inside the Earth from carbon deposits that date back to the formation of the planet. In essence, the theory states that oil, much like any other mineral resource, has been in existence in the Earth's crust and mantle the entire time the planet has been in existence. As time passes, heavier minerals such as iron and nickel move deeper into the Earth's mantle, ending up in the core, whereas lighter minerals such as silicon and carbon move up the Earth's internal structure, slowly ending up at the surface. As this process of mineral migration can take millions of years, the proponents of this theory believe that there are still greater quantities of oil and gas located very, very deep in the Earth's surface, much deeper than existing deep-sea oil fields, perhaps not even in the Earth's crust, but in the mantle. In an effort to prove this theory, Thomas Gold led massive drilling projects in Sweden that attempted to find oil fields in an area that was not expected to have any sizeable quantity of traditional oil. After drilling two boreholes that went 6.5 km into the Earth's surface, the results were still inconclusive. Funding and technical problems meant the project had to be closed down in the early 1990s. However, proponents of



the theory point at oil and natural gas deposits in Vietnam and China as evidence of the abiogenic origin of oil, but as of today, the theory remains unproven and most geologists suspect that it is obsolete.

The significance of the abiogenic theory is that it does lead to questions about the true abundance of oil and natural gas in the Earth's surface. The presence of lakes, seas, and oceans of hydrocarbons, such as methane, on distant planets and moons, such as on Saturn's moon Titan, are often used as evidence that abiogenic processes can result in the production of hydrocarbons on a large scale on a planetary surface. However, even if the theory were later proven to be true, it would not help much. Modern drilling technology is expensive and extremely risk-intensive. Even as we start to utilize even more dangerous techniques, such as fracking, in order to obtain fossil fuels from the Earth's surface, there will come a point when the risks, technological limitations, and cost will outweigh the profits of oil so obtained. Even if we were to obtain this mantle oil at a profit, the dangers of increasing greenhouse gas emissions from burning even more fossil (or abiogenic) fuel should make us think twice about the consequences of our actions. ■





# CURRENT R&D SOLAR

**An overview of the Romanian renewable energy sector**  
Renewable and Sustainable Energy Reviews, Volume 24,  
August 2013, Pages 149–158  
*Sofia Elena Colesca, Carmen Nadia Ciocoiu*

The past 20 years have brought significant changes in the evolution of the energy sector in Romania. Even if it is considered a country with high potential for renewable energies, these are not fully exploited. European Union accession has determined significant changes in energy policy, energy legislation alignment and promotion of renewable energy. In this context, the paper aims to offer a comprehensive overview of the renewable energy sector in Romania. Based on an extensive research of Romanian energy policy and legislation, the article presents the Romanian energy sector and the current status of the main renewable energy sources. The information was gathered from the available data in statistical reports, energy and environment strategies, energy companies' reports, NGO studies, and research articles.

**Renewable energy in buildings in China: A review**  
Renewable and Sustainable Energy Reviews, Volume 24,  
August 2013, Pages 1–8  
*Xueliang Yuan, Xujiang Wang, Jian Zuo*

Utilizing renewable energy in buildings helps to reduce consumption of conventional energy and to achieve low carbon economy. The past decades have witnessed a rapid development of renewable energy in buildings globally. China is no exception. The policies, regulations, and strategic

plans related to renewable energy in buildings are critically analysed in this study with an aim to present an integrated policy framework. Furthermore, the current situation of utilizing various types of renewable energy resources in buildings and main barriers are discussed. Finally the development plan for renewable energy in buildings is presented according to the national policies. This study offers a comprehensive and systematic reference for the renewable energy in buildings in China.

**Overall review of renewable energy tariff policy in China: Evolution, implementation, problems and countermeasures**  
Renewable and Sustainable Energy Reviews, Volume 25,  
September 2013, Pages 260–271  
*Zeng Ming, Liu Ximei, Li Na, Xue Song*

The rapid growth of China's economy has accelerated its energy demand, which is becoming more urgent. It is essential to exploit renewable energy because of the limited conventional energy, high energy consumption, and serious pollution. China will strengthen the development and utilization of wind, solar, biomass, and other renewable energies in the future, which will reduce the level of carbon emissions. However, China's rapid growth in renewable energy, particularly wind, has been accompanied with some growing pains, and there is room for improving the legal framework to address these challenges. A reasonable renewable energy tariff policy has a pivotal role in changing China's current situation. This paper introduced the current development situation of renewable energy, analysed the

evolution and implementation effect of the renewable energy tariff policy, and discussed the problems of the renewable energy tariff policy in China. On this basis, this article proposed feasibility tariff policy recommendations to solve the problems, which have important theoretical significance and practical application value.

**A novel concept for a renewable network within municipal energy systems**  
Renewable Energy, Volume 60, December 2013, Pages 79–87  
*Anja Kostevšek, Leon Cizelj, Janez Petek, Aleksandra Pivec*

Renewable energy sources are amongst the more widely acceptable options for the future transformations of existing energy systems. The complexities of such transformations call for various comprehensive preparatory actions. Amongst them, the organization of a multifaceted renewable value-chain into a renewable network may well be crucial for the successful utilization of renewable energy sources in the future. This paper proposes a novel concept for renewable network covering entire renewable value chain with division on supply, demand and technology sections. In the past, each section has been addressed separately. The organization of renewable network covering all sections is deemed to be vital for accomplishing the optimal distribution and deployment of renewable energy sources. Constant technological advancements within the renewable sector indicate the significance of a technology section within a renewable network. The appropriate arrangement of various stakeholders involved throughout the entire value-chain, which includes all sections of a renewable network, is therefore crucial for the further development of a renewable sector. The proposed concept of a renewable network would support the effective operation of a renewable value-chain within a municipality through the establishment of local virtual energy cooperatives aimed at fulfilling energy needs and supporting the development of the community. The applicability of the proposed concept is demonstrated through the development of a biomass network within the municipality of Cirkulane, Slovenia.

**Knowledge management mapping and gap analysis in renewable energy: Towards a sustainable framework in developing countries**  
Renewable and Sustainable Energy Reviews, Volume 20,  
April 2013, Pages 576–584  
*M El Fadel, G Rachid, R El-Samra, G Bou Boutros, J Hashisho*

This paper presents a mapping of knowledge management in renewable energy (RE) promoted through international and regional organizations with emphasis on gap analysis

for the purpose of increasing RE deployment in developing countries. The knowledge mapping showed that most efforts are focused on RE information sharing and awareness raising, followed by policy assistance and technology transfer. Priorities seem vague with minimal close implementation, coordination, and evaluation whereby technology transfer and capacity building efforts do not always cater to the needs of benefiting countries with a lack of specialized RE financial mechanisms that provide incentives for countries to invest in RE. Equally significant, limited efforts are discerned about joint research initiatives with a slow progress towards standardization and certification of RE technologies. A general framework is proposed with a definition of short, medium and long-term undertakings towards increased RE penetration in developing countries. The profile of well-positioned organizations to adopt such a framework is identified on the basis of a SWOT analysis.

**Electric vehicles and the electric grid: A review of modeling approaches, impacts, and renewable energy integration**  
Renewable and Sustainable Energy Reviews, Volume 19,  
March 2013, Pages 247–254  
*David B Richardson*

Electric vehicles (EVs) and renewable energy sources offer the potential to substantially decrease carbon emissions from both the transportation and power generation sectors of the economy. Mass adoption of EVs will have a number of impacts and benefits, including the ability to assist in the integration of renewable energy into existing electric grids. This paper reviews the current literature on EVs, the electric grid, and renewable energy integration. Key methods and assumptions of the literature are discussed. The economic, environmental and grid impacts of EVs are reviewed. Numerous studies assessing the ability of EVs to integrate renewable energy sources are assessed; the literature indicates that EVs can significantly reduce the amount of excess renewable energy produced in an electric system. Studies on wind–EV interaction are much more detailed than those on solar photovoltaics (PV) and EVs. The paper concludes with recommendations for future research.

**Renewable energy certificate mechanism in India: A preliminary assessment**  
Renewable and Sustainable Energy Reviews, Volume 22,  
June 2013, Pages 380–392  
*Sandeep Kumar Gupta, Pallav Purohit*

The Indian National Action Plan for Climate Change (NAPCC) envisages several measures to address global climate



change. One of the important measures identified involves increasing the share of renewable energy in total electricity consumption in the country. This would mean NAPCC envisages renewable energy to constitute approximately 15 per cent of the energy mix of India by 2020. To achieve the target set by the NAPCC, Indian Ministry of Power launched Renewable Energy Certificate (REC) mechanism in November 2010. However, participation in the REC markets is low and RECs have failed to attract significant investment so far. In this study a preliminary attempt has been made to assess the performance of existing REC mechanism in India. After highlighting the salient features of the Indian renewable energy policy framework a brief description of renewable purchase obligation (RPO) and source specific RPOs for different states is discussed along with an overview of REC market in India to date.

The performance of Indian REC mechanism is evaluated by cost competitiveness, decentralized distributed generation and renewable energy portfolio diversity and their effectiveness has also been measured on the basis of the available data. Although, it is difficult to make any conclusive remark on the success or failure of REC mechanism due to its short experience, this study examines the process to date to come out with some recommendations which can be used to fine tune the functioning of existing REC market in India. For instance, REC price bounds should be revised because it has been not explicitly supporting cost competitiveness by offering 60.33 per cent higher average price than the existing average feed-in tariff (FIT). It is also observed that state-wise contribution in registered capacity is skewed towards few states like Tamil Nadu (27 per cent), Maharashtra (23 per cent), and Uttar Pradesh (22 per cent), which puts pressure on policy-makers to restructure the existing REC mechanism.

**Renewable Energy Certificate and Perform, Achieve, Trade mechanisms to enhance the energy security for India**

Energy Policy, Volume 55, April 2013, Pages 669–676  
Rajesh Kumar, Arun Agarwala

The Renewable Energy Certificate and Perform Achieve Trade mechanisms in India are designed to target energy generation and saving, respectively, in line with Clean Development Mechanism implemented by United Nations Framework Convention on Climate Change. The Renewable Energy Certificate System is a voluntary regulation in India for renewable energy generators and is designed for effective implementation of inter-state transactions by introducing the Renewable Purchase Obligation regulation for consumers and a flexible trading platform for transactions

across the country. Another initiative, the Perform Achieve Trade scheme, is an enhanced energy efficiency trading mechanism based on consumption targets that require large energy user sectors to improve efficiency by 1–2 per cent per year. The Perform Achieve Trade programme has introduced mechanisms for the identification of industry sector, designated customer, specific energy consumption and target setting. The Perform Achieve Trade design issues are in test phase in the first cycle of the scheme which will run from 2012 to 2015. This paper discusses key design issues about boundary and target setting for Renewable Energy Certificate and Perform Achieve Trade energy saving certificate (ESCert) A data sharing and trading mechanism for Perform Achieve Trade is also proposed for review and coordination among regulator, designated consumers and traders in the market.

**Carbon payback period for solar and wind energy project installed in India: A critical review**

Renewable and Sustainable Energy Reviews, Volume 23, July 2013, Pages 80–90  
C Marimuthu, V Kirubakaran

All renewable energy systems make some contribution to climate change. This is due to fuel combusted for their construction and as back up energy during their operation. Accurate calculation of greenhouse gas emission per kilowatt hour of electricity is difficult but is an important part of policy making and planning. This study, an attempt has been made to analyse and review the development and potential of wind and solar energy in India. LCA has been carried out for the on shore wind turbine and poly crystalline PV module. Based on the past studies, life cycle inventory data has been collected for the investigation. Using that data, the detailed investigation has been made for the existing grid connected 1.65 MW wind turbine project in and around Udumalpet, Tamil Nadu and 25 kW Roof top solar PV Power plant at Sewa Bhawan, New Delhi. Carbon intensity, energy pay back period and carbon pay back period for the above system have been calculated and compared with each other ■

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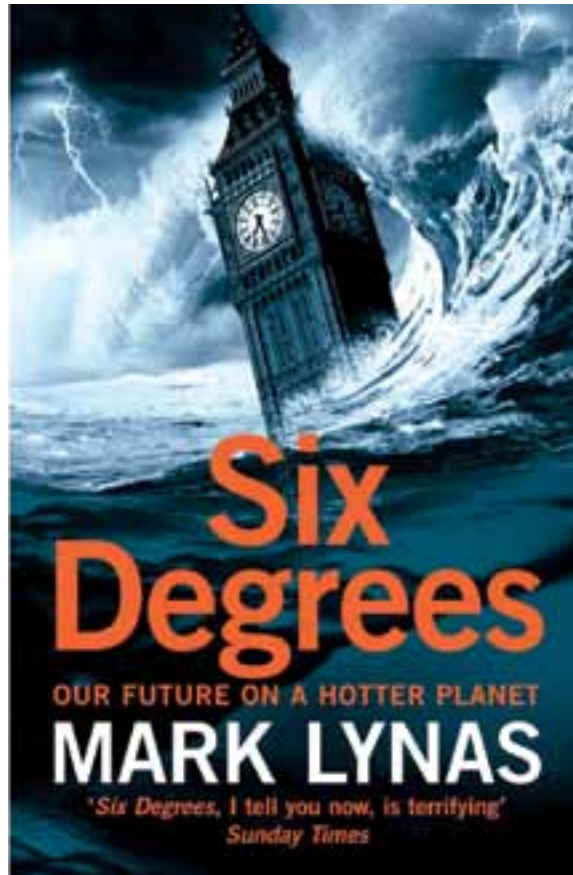
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**Author:** Mark Lynas  
**Year:** 2009  
**Pages:** 367  
**Publisher:** Fourth Estate

# Six Degrees

OUR FUTURE ON A HOTTER PLANET  
**MARK LYNAS**

**H**indsight is a terrible thing. The infinite little causes and effects that when combined create the reality we inhabit are swept away under broad brushstrokes and simple ideas. The rose-eyed monster makes ideas that were difficult to grasp in their time seem obvious to later generations. We consider the Greeks stupid for believing the world extended merely from Spain in the west to India in the east, and from the Caspian Sea to the South Sudan, north to south. They knew the world was round and had calculated the circumference of the Earth to a remarkable degree of accuracy,

seeing that their only instruments for the job were a stick, some thread, and knowledge of the principles of trigonometry. Thus, we marvel at their ingenuity, but smirk derisively at their diminutive worldview.

The Greek scholar Eratosthenes, who lived around 2,200 years ago, had calculated that the Earth had a circumference of 252,000 stadia, which translates to roughly 46,620 km, a figure that comes pretty close to the modern calculation of 40,075 km at the equator. Surely, they would have known that their “world” occupied only perhaps a quarter of the surface of the planet. And yet, our magnificent global

civilization, the progeny of people who harnessed the power of the atomic nucleus, a civilization that has left the shores of the cosmic ocean to explore a few neighbouring worlds, a global people connected by an array of communicative devices and possessors of trinkets that our forebears could not begin to fathom; we too are guilty of possessing a diminutive worldview.

We, the denizens of the twentieth and twenty-first centuries, are aware of the byproducts of industrial processes; we know the gases that are emitted when we burn coal, oil, and natural gas in as large quantities as we do. We are aware of the chemical and

thermodynamic properties of these gases. The greatest minds of many a generation put their lives at risk in the study of the then-nascent science of chemistry to be able to give us the comprehensive understanding we now take for granted. We know the delicate balance of gases that surrounds us in our atmosphere, a wafer thin shield that keeps us alive and ensures that the Earth is not just another charred and frozen piece of rock floating aimlessly around the infinite abyss.

Our knowledge of the sciences of geology, dendrochronology, and paleoclimatology lends us an understanding of the climate of the Earth in the eons gone by, and using the power of our most recent and perhaps greatest innovation, computer technology, we can create reproductions, recreations, and simulations of these ages gone past.

Computer modelling has allowed us to be able to map out an almost entirely accurate climate history of the planet Earth. And despite accumulating all these extraordinary individual strands of information, we as a species refuse to acknowledge what they imply: that we, the human race, are destroying our home, that our greed for so-called progress is leading us to destroy the very lands and seas that give us the materials to achieve this “growth”. We are in the midst of slowly killing our golden goose, and our chosen method of execution appears to be carbon dioxide poisoning.

Mark Lynas’ extraordinary book is, to use that most trite literary review cliché, a tour de force. It was rightly awarded the highly prestigious Royal Society Prize for Science Books, an accolade whose previous recipients include some of the greatest science

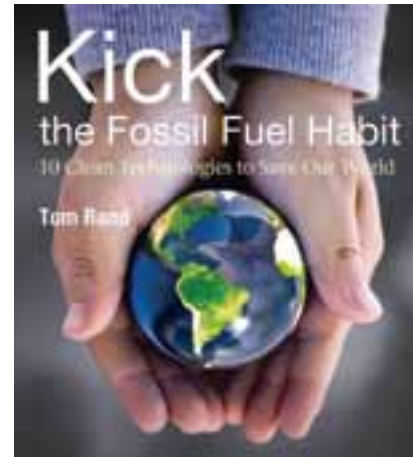
communicators of our generation — Stephen Hawking, Brian Greene, Jared Diamond, Stephen Jay Gould, and Roger Penrose, to name a few. In his book, Lynas carefully, methodically, in a language and tone that neither proselytizes nor panders, provides us with a summary of the research on the impacts of climate change on global society. Each chapter was formed from the scouring of many papers and journals on climate research, and highlights the kinds of social, political, and meteorological changes we can expect around the world for each degree Celsius increase in global temperatures. The book is a clarion call to the people of the twenty-first century, that our progeny — if they survive — should not view this work as we view Eratosthenes’ calculation today and wonder why we were so blind to the obvious truth. ■





## Kick the Fossil Fuel Habit: 10 Clean Technologies to Save Our World

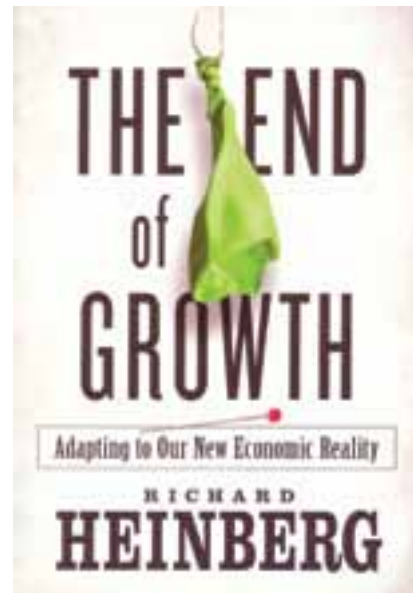
There are many analogies that can be drawn between an individual's bad habit of smoking and the global dependence on fossil fuels. Smoking is terrible for the body, just as wantonly burning fossil fuels is terrible for the planet. They are both protected by very rich and powerful lobby groups that use media exercises to portray an unhealthy obsession as being fashionable. And while people are aware of the problems, they continue to smoke and use fossil fuels because quitting at one go seems impossible. In his book, *Kick The Fossil Fuel Habit: 10 Clean Technologies to Save Our World*, clean energy venture capitalist Tom Rand describes how it is possible for the human race to collectively kick our fossil fuel habit before the global economic civilization that we have worked so hard to build kicks the bucket. The book is a direct attack on one of the most commonly peddled excuses by the climate change denial and oil lobbies: we must continue our dependence on fossil fuels simply because there is no alternative that can power the ever-expanding engine of economic progress around the world. Rand clearly outlines ten clean energy technologies that, when combined, can ensure that the human race can quit fossil fuels without having to sacrifice economic and social progress. In fact, the ten clean technologies highlighted by the book (Solar, Wind, Geothermal, Biofuels, Hydropower, Ocean, Smart Buildings, Transportation, Energy Efficiency, and the Energy Internet) can help foster greater economic equality and social cohesion, bringing nations that are denied opportunities at growth due to their lack of availability of fossil fuel resources the chance to catch up to the rest of the world. The technologies mentioned are dependent on resources that are renewables and readily abundant throughout the world. Rand's book puts a positive spin on a problem that seems to attract only negative press. ■



**Author:** Tom Rand  
**Year:** 2010  
**Pages:** 240  
**Publisher:** Eco Ten Publishing, Inc.

## The End of Growth: Adapting to Our New Economic Reality

Author of previous bestsellers on climate change and resource depletion such as *Peak Everything*, *The Party's Over*, and *Blackout*, Richard Heinberg brings with him a detailed understanding of the impending crises of peak oil and other resource depletions, along with a rich experience at explaining these topics to the layman. In his book *The End of Growth*, Heinberg talks about how the exuberant and indulgent lifestyles that have been prevalent throughout the developed world for the last twenty years will soon be a thing of the past. Much like how the luxury, gluttony, and decadence witnessed in the turbulent 1920s was followed by the gritty reality of the great depression of the 1930s, our over-indulgent lifestyles have caused a problem that everyone has heard of but few are willing to accept and even fewer are bracing to confront and potentially mitigate. Looking at how the path to recovery from the global recession we are in the midst of is being made needlessly difficult due to an irrational belief in consumption being equivalent to growth, Heinberg outlines ways in which economic recovery is possible, provided it comes with a newfound sense of responsibility for our actions. He re-evaluates economic paradigms built on outdated principles and outlines ways in which individuals, families, and communities can survive and thrive in a brave new world of food, water, and energy shortages, crushing debt, and the social and political instability that is bound to create as a corollary. While a few people in isolated pockets around the world try to stop the train wreck that is our consumption-obsessed global civilization, Heinberg's book is a survival guide for how to live in a world post the crash. ■



**Author:** Richard Heinberg  
**Year:** 2011  
**Pages:** 336  
**Publisher:** New Society Publishers

## Toxic Sludge is Good For You: Lies, Damn Lies and the Public Relations Industry

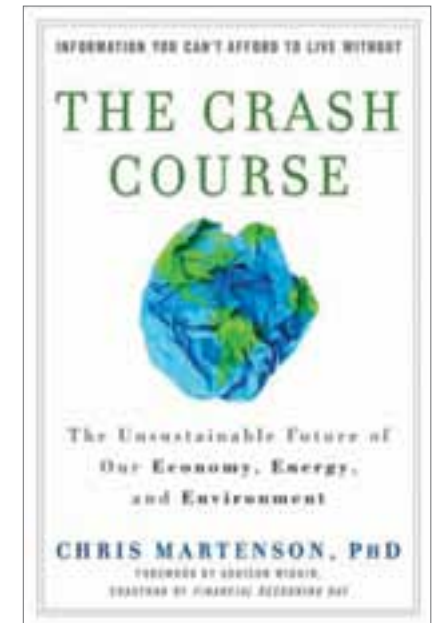
Ever thought about why it is so difficult to find clear, crisp, understandable news about any topic in today's media? Why are civilians killed in war zones around the world not called "casualties" or "civilian deaths", but rather "collateral damage", a phrase that evokes perhaps a decaying, empty old building, rather than innocent victims? The answer is the PR Industry. While there is definitely a need for public relations in a media-obsessed world such as ours, some of the practices indulged in by a few powerful PR agencies that make up for in viciousness what they lack in moral rectitude, are capable of causing widespread death and destruction, bringing pain and misery to many while lining the pockets of their clients (and themselves) with gold. Environmentally damaging practices are disguised as projects that will bring greater economic growth and prosperity to the middle class, toxic waste dumped into rivers are re-branded "bio solids" and are praised for the nutritional value they supposedly add to the soil, and a potentially catastrophic explosion at a nuclear power plant is referred to by PR agents as a "spontaneous energetic disassembly". Stauber and Rampton's shocking exposé on the practices of disingenuous PR groups, lobbying firms, and supposedly independent agencies to distort and re-brand the truth until something horrible is palatable to their average TV viewer is necessary reading in today's world of hyperbolic opinion saturation and media theatre. The efforts of such organizations at stopping any information that might be harmful or truthful to their clients from ever reaching the common person are a chilling precursor to the kind of censorship and repression that were usually the forte of dystopian literature. ■



**Author:** John Stauber and Sheldon Rampton  
**Year:** 2002  
**Pages:** 224  
**Publisher:** Common Courage Press

## The Crash Course: The Unsustainable Future of Our Economy, Energy, and Environment

Economic researcher and futurist Dr Chris Martenson begins the book with a dire warning, "The next twenty years will be completely unlike the last twenty years. The decisions you make today are critical." Discussing the urgent need for society, especially in developed countries, to re-evaluate the highly unsustainable practices inherent in their obsessive pursuit for economic and technological progress at the cost of global resource security, Dr Martenson describes how the global economy faces a plethora of challenges, crises, and potential disasters looming just beyond the horizon. Describing the approaching peaks in minerals and energy supply, right from Peak Oil (which may or may not have already occurred; the nature of peak oil is such that we will only find out afterwards) to peaks in critical mineral resources, such as phosphorus or gallium, Dr Martenson talks about how sans raw materials, the industrial revolution that began over 200 years ago could come to a very sudden crashing halt. If the impending mineral cliff was not bad enough, we are also facing ecological disaster caused by anthropogenic climate change and wanton destruction of the Earth's environment and its delicate biosphere recovery systems. And perhaps most critically, he describes the impending crises in food and water security, highlighting the futility of trying to feed the 9.5 billion inhabitants of the planet by 2050 on dwindling arable land, with lesser and lesser fresh water, and without the large-scale industrial agricultural techniques pioneered in the 20th century. With challenge comes opportunity and *The Crash Course* offers a positive vision for how to reshape society to be more balanced, resilient, and sustainable. ■



**Author:** Dr Chris Martenson  
**Year:** 2011  
**Pages:** 336  
**Publisher:** Wiley





# RENEWABLE ENERGY TECHNOLOGY DEVELOPMENT

## **N**ot Just Blowing in the Wind: Compressing air for renewable energy storage

Compressed air energy storage plants could help save the region's abundant wind power — which is often produced at night when winds are strong and energy demand is low — for later, when demand is high and power supplies are more strained. These plants can also switch between energy storage and power generation within minutes, providing flexibility to balance the region's highly variable wind energy generation throughout the day.

### **Geologic Energy Savings Accounts**

All compressed air energy storage plants work under the same basic premise. When power is abundant, it's drawn from the electric grid and used to power a large air compressor, which pushes pressurized air into an underground geologic storage structure. Later, when power demand is high, the stored air is released back up to the surface, where it is heated and rushes through turbines to generate electricity. Compressed air energy storage plants can regenerate as much as 80 per cent of the electricity they take in.

The world's two existing compressed air energy storage plants — one in Alabama, the other in Germany — use human-made salt caverns to store excess electricity. The PNNL-BPA study examined a different approach: using natural, porous rock reservoirs that are deep underground to store renewable energy.

Interest in the technology has increased greatly in the past decade. About 13 per cent, or nearly 8,600 megawatts, of the Northwest's power supply comes from wind. This prompted BPA and PNNL to investigate whether the technology could be used in the Northwest.

To find potential sites, the research team reviewed the Columbia Plateau Province, a thick layer of volcanic basalt

rock that covers much of the region. The team looked for underground basalt reservoirs that were at least 1,500 feet deep, 30 feet thick, and close to high-voltage transmission lines, among other criteria.

They then examined public data from wells drilled for gas exploration or research at the Hanford Site in south eastern Washington. Well data was plugged into PNNL's STOMP computer model, which simulates the movement of fluids below ground, to determine how much air the various sites under consideration could reliably hold and return to the surface.

The study indicates both facilities could provide energy storage during extended periods of time. This could especially help the Northwest during the spring, when sometimes there is more wind and hydroelectric power than the region can absorb. Power system managers would then have a few options to keep the regional power grid stable in such a situation, including reducing power generation or storing the excess power supply. Energy storage technologies such as compressed air energy storage can help the region make the most of its excess clean energy production.

<http://www.sciencedaily.com/releases/2013/05/130520142823.htm>

### **Bacteria Use Hydrogen, Carbon Dioxide to Produce Electricity**

Researchers at the University of Massachusetts, Amherst report their findings at the 113<sup>th</sup> General Meeting of the American Society for Microbiology.

Under the leadership of Derek Lovley the lab group has been studying *Geobacter* bacteria since Lovley first isolated *Geobacter metallireducens* in sand sediment from the Potomac River in 1987. *Geobacter* species are of interest because of their bioremediation, bioenergy potential, novel electron transfer capabilities, ability to transfer

electrons outside the cell, and transport these electrons over long distances via conductive filaments known as microbial nanowires.

Researchers studied a relative of *G. metallireducens* called *Geobacter sulfurreducens*, which has the ability to produce electricity by reducing organic carbon compounds with a graphite electrode such as iron oxide or gold to serve as the sole electron acceptor. They genetically engineered a strain of the bacteria that did not need organic carbon to grow in a microbial fuel cell.

<http://www.sciencedaily.com/releases/2013/05/130519191102.htm>

### **Artificial Forest for Solar Water-Splitting: First fully integrated artificial photosynthesis nanosystem**

In the wake of the sobering news that atmospheric carbon dioxide is now at its highest level in at least three million years, an important advance in the race to develop carbon-neutral renewable energy sources has been achieved. Scientists with the US Department of Energy (DOE)'s Lawrence Berkeley National Laboratory (Berkeley Lab) have reported the first fully integrated nanosystem for artificial photosynthesis. While "artificial leaf" is the popular term for such a system, the key to this success was an "artificial forest." Artificial photosynthesis, in which solar energy is directly converted into chemical fuels, is regarded as one of the most promising of solar technologies. A major challenge though is to produce hydrogen cheaply enough to compete with fossil fuels. This requires an integrated system that can efficiently absorb sunlight and produce charge-carriers to drive separate water reduction and oxidation half-reactions.

When sunlight is absorbed by pigment molecules in a chloroplast, an energized electron is generated that moves from molecule to molecule through a transport chain until ultimately it drives the conversion of carbon dioxide into carbohydrate sugars. This electron transport chain is called a "Z-scheme." Yang and his colleagues also use a Z-scheme in their system but deploy two Earth abundant and stable semiconductors — silicon (for the hydrogen-generating photocathode) and titanium oxide (for the oxygen-generating photoanode) — loaded with co-catalysts and with an ohmic contact inserted between them. The tree-like architecture was used to maximize the system's performance as the dense arrays of artificial nanowire trees suppress sunlight reflection and provide more surface area for fuel producing reactions. Under simulated sunlight, this integrated nanowire-based artificial photosynthesis system achieved a 0.12 per cent solar-to-fuel conversion efficiency. Although comparable to some natural

photosynthetic conversion efficiencies, this rate will have to be substantially improved for commercial use.

<http://www.sciencedaily.com/releases/2013/05/130516142654.htm>

### **New Uses for Tiny Carbon Nanotubes: Adding ionic liquid to nanotube films could build smaller gadgets**

The atom-sized world of carbon nanotubes holds great promise for a future demanding smaller and faster electronic components. Nanotubes are stronger than steel, smaller than any element of silicon-based electronics, and have better conductivity, which means that they can potentially process information faster while using less energy. The challenge has been figuring out how to incorporate all those great properties into useful electronic devices. A new discovery by four scientists at the University of California, Riverside has brought us closer to the goal. They discovered that by adding ionic liquid — a kind of liquid salt — they can modify the optical transparency of single-walled carbon nanotube films in a controlled pattern. An ionic liquid contains negative and positive ions which can interact with the nanotubes, dramatically influencing their ability to store an electrical charge. That increases or decreases their transparency, similar to the way that glasses darken in sunlight. By learning how to manipulate the transparency, scientists may be able to start incorporating nanotube films into products that now rely on slower or heavier components, such as metal oxide.

The scientists still need to study the economic viability of using nanotube film, but Bekyarova said one possible advantage would be that carbon nanotubes are ultra-thin — about 1,000 times smaller than a single strand of hair — so you would need very little to cover a large area, such as the windows of a large building which would darken when it's hot outside and become lighter when it's cold.

Itkis said that nanotube films also hold great promise in building lighter and more compact analytical instruments such as spectrometers. In this application, a nanotube film with an array of electrodes can be used as an electrically configurable diffraction grating for an infrared spectrometer, allowing the wavelength of light to be scanned without moving parts.

Furthermore, by using addressable electrodes, the spatial pattern of the induced transparency in the nanotube film can be modified in a controlled way and used as an electrically configurable optical media for storage and transfer of information via patterns of light. Carbon nanotubes have great potential, but there is still plenty of work to be done to make them useful in electronics and optoelectronics, Haddon said.

<http://www.sciencedaily.com/releases/2013/05/130514190643.htm>





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## NATIONAL AND INTERNATIONAL EVENTS

**Second International Conference on Advanced Materials, Energy, and Environments**

8-9 August 2013  
Yokohama, Japan  
Website: <http://thinfilmmtechno.net/index.php/icmee-13>

**Annual International Conference on Power, Energy and Electrical Engineering (PEEE 2013)**

26-27 August 2013  
Singapore  
Website: <http://elec-eng-conf.org/>

**2013 Western Energy Policy Research Conference**

5-6 September 2013  
Portland, Oregon, United States of America  
Website: <http://epi.boisestate.edu/conference>

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5-6 September 2013  
Portland, Oregon, United States of America  
Website: <http://epi.boisestate.edu/conference>

**Innovations in Energy, Power and Electrical Machines**

5-7 September 2013  
Istanbul, Turkey  
Website: <http://iepem-scoop.org>

**2013 3rd International Conference on Energy and Environmental Science (ICEES 2013)**

7-8 September 2013  
Shanghai, China  
Website: <http://www.icees.org/>

**Asia Pacific Clean Energy Summit and Expo**

9-11 September 2013  
Honolulu, Hawaii, United States of

America  
Website: <http://www.ct-si.org/events/APCE2013/>

**ICCE 2013: International Conference (and exhibition) on Clean Energy**

9-11 September 2013  
Ottawa, ON, Canada  
Website: <http://iaemm.com/ICCE2013/>

**Chilean Renewable Energy Conference 2013**

10-11 September 2013  
Santiago, Chile  
Website: <http://www.greenpowerconferences.com/CIREC>

**2013 Workshop on Bio-Energy and Bio-Fuels and their Impact on the Global Economy**

16-18 September 2013  
Brisbane, QLD, Australia  
Website: [http://www.ausihem.org/index.php?p=1\\_91\\_2013-Workshop](http://www.ausihem.org/index.php?p=1_91_2013-Workshop)

**4th Biobased Chemicals: Commercialization and Partnering Conference**

16-17 September 2013  
San Francisco, CA, United States of America  
Website: <http://www.gtcbio.com/conference/biobased-chemicals-commercialization-and-partnering-overview>

**The 8th Conference on Sustainable Development of Energy, Water and Environment Systems—SDEWES**

22-27 September 2013  
Dubrovnik, Croatia (Hrvatska)  
Website: <http://www.dubrovnik2013.sdewes.org>

**Telecoms for Smart Grids**

23-24 September 2013  
London, England, United Kingdom  
Website: <http://www.smi-online.co.uk/2013telecomsforsmartgrids3.asp>

[13telecomsforsmartgrids3.asp](http://www.smi-online.co.uk/2013energy-waste1.asp)

**Energy from Waste 2013**

25-26 September 2013  
London, United Kingdom  
Website: <http://www.smi-online.co.uk/2013energy-waste1.asp>

**28th European Photovoltaic Solar Energy Conference and Exhibition (28th EU PVSEC)**

30 September-4 October 2013  
Paris, France  
Website: <http://www.photovoltaic-conference.com>

**Renewable Energy India Expo**

The 7th edition of Renewable Energy India (REI) Expo 2013 is Asia's largest congregation of the Renewable Energy industry. REI Expo provides an unmatched platform to showcase the best technological advancements in the renewable energy sector. The Exhibition also opens up avenues to discuss opportunities and challenges faced in the development of the renewable energy segment. REI caters to the solar PV, solar thermal, wind, biomass, geothermal, hydro and energy efficiency industry segments. International participation from Belgium, Canada, Japan and United States of America will open up new business avenues for the Indian market.

**Date/Time**

12-14 September 2013, 1000-1800 hrs (and 1000-1700hrs on 14 September)  
UBM India  
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Email: [pooja.patil@ubm.com](mailto:pooja.patil@ubm.com)  
Website: [http://www.ubmindia.in/renewable\\_energy](http://www.ubmindia.in/renewable_energy)



# RENEWABLE ENERGY AT A GLANCE

Sr. No.	States	Installed Capacity (MW)
1	Andhra Pradesh	23.15
2	Arunachal Pradesh	0.025
3	Chhattisgarh	4
4	Delhi	2.525
5	Goa and UT	1.685
6	Gujarat	824.09
7	Haryana	7.8
8	Jharkhand	16
9	Karnataka	14
10	Kerela	0.025
11	Madhya Pradesh	11.75
12	Maharashtra	34.5
13	Odisha	13
14	Punjab	9.325
15	Rajasthan	442.25
16	Tamil Nadu	17.055
17	Uttarakhand	5.05
18	Uttar Pradesh	12.375
19	West Bengal	2
<b>Total</b>		<b>1440.605</b>

Note :The data is compiled on the basis of information obtained from IREDA, NNVN, State Agencies and Project Developers.

Projects	Capacity (MW)
Projects Under JNNSM	421.9
Projects under the State Policy	824.09
Projects Under RPSSGP/GBI Scheme	91.8
Projects Under REC Scheme	23.905
Other projects	78.91
<b>Total</b>	<b>1440.605</b>